THE

ELECTRICAL REVIEW.

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THE RELATION BETWEEN INSULATION RESISTANCE AND TESTING PRESSURE.

IN a recent issue of our contemporary, *L'Electricien*, there appears a short article criticising a statement on this subject made by Mr. Preece in his paper on "The Specification of Insulated Conductors." This statement ran as follows:—"There is a widespread impression that the insulation varies inversely with the potential differences employed, and that the higher the voltage used the more accurate the result. This is a mistaken notion." This assertion is objected to, in the first place, on the ground that the generally accepted opinion is not that the insulation varies inversely as the pressure, that is to say, that the product of pressure and insulation is constant but rather that the insulation becomes less when measured with a higher battery power than with a low one. The second objection resolves itself into a complaint concerning the tendency of English writers to neglect work done in other countries, and the question is asked whether Mr. Preece ignores the experiments on this subject which were carried out in 1889 by M. Heim, of Hanover, and which have fully proved, our contemporary says, that a diminution of insulation accompanies an increase of testing pressure.

We think our contemporary is hardly justified in charging English writers with neglecting the work done in other countries, and in this particular case we know that many electricians are fully acquainted with the particulars of the series of experiments made by M. Heim; but that, whilst recognising them as a careful attempt at settling this question, they cannot agree with the deductions made from the tests. The reason for this is not difficult to see, as although great precautions were taken by M. Heim to eliminate errors due to change of temperature and to residual charge in the dielectric, there still remains a considerable want of uniformity in the results; indeed, when the resistance was measured at different times with the same battery power, the results differed to about the same extent as they did when measured with different battery powers. For instance, the resistance of a gutta-percha core when measured with 460 volts, is given as 6·6 per cent. less than with 52 volts, this figure being the mean of eight tests; but at the same time we find that in one of these tests the fall of resistance is only 4·6 per cent., whilst in another it is as much as 10·6 per cent. Again, we find a variation of about 7 per cent. between tests made at the same pressure on different days, even after corrections have been made for the small differences in temperature which were recorded.

So far as we are aware, in every case, save one, in which such tests have been made, the variation of insulation has been between 5 and 10 per cent., and although, in some cases, this has always been in a direction pointing to a dimi-

nution of resistance with increased testing pressure, in others the resistances have increased at one time, and diminished at another, when the pressure has been augmented, and we are therefore obliged to consider the question, so far as the published results of these tests is concerned, as an open one. The one exception referred to above is that of the figures quoted by Mr. Siemens during the discussion of Mr. Preece's paper, and in these the variation is much more pronounced, amounting to about 25 per cent. drop when the pressure was raised from about 150 to 1,800 volts. Here there appears to be a variation which cannot be accounted for, as is possible in the other cases, by errors due to change of temperature or residual charge, and the tests are therefore so important, that it would be of extreme interest if Mr. Siemens would publish full details of the cables tested, and of the method of testing them, and so help to clear up some of the doubts still remaining as to the effect of increased pressure in tests of insulation.

RESEARCHES ON THE ALLEGED OCCLUSION OF HYDROGEN BY LEAD IN THE SECONDARY BATTERY.

Since the introduction of secondary batteries by Planté, Faure and others, a large amount of work has been done by various observers in order to obtain a clearer insight into the various changes which occur during the charging and discharging of the cells. Amongst the many obscure questions which have received attention, that of the occlusion of hydrogen by metallic lead is one which has given rise to contradictory answers. Only a week or two ago (*vide* Electrical Review, April 29th), we noticed a paper by Neumann and Streintz, which appeared in the *Monatshefte für Chemie*, xii., p. 642, the object of which was to prove the assumption that hydrogen is absorbed in large quantities by lead. In our remarks on this work we observed that the results obtained could scarcely be regarded as satisfactory.

Dr. John Shields, referring to this research in a paper written from Leipzic, and published in the *Chemical News*, expresses his opinion that hydrogen is not absorbed in large quantities by lead; indeed, that this metal practically occludes no hydrogen, and that it does not play the important part in the chemistry of secondary batteries which has often been ascribed to it. He severely criticises the methods employed by Neumann and Streintz in their investigation, and reviews a mass of evidence which tends to support his assertion, which we will briefly notice.

Frankland was perhaps the first to institute experiments to decide the question of the absorption of hydrogen by lead. He produced the metal electrolytically, and examined the spongy substance thus obtained in order to see whether it consisted solely of metallic lead, or contained hydrogen associated with it any way. But when the reduced mass was melted in a combustion tube no measurable quantity of hydrogen was given off. [*Proc. Roy. Soc.*, xxxv., p. 67.]

Graham found that palladium, which had served as the negative electrode during the electrolysis of dilute sulphuric acid, and which thereby becomes charged with a large quantity of hydrogen, possesses the property of reducing salts. Gladstone and Tribe have applied this method to the spongy lead, but they have found that the amount of hydrogen associated with the reduced lead is almost inappreciable ("The Chemistry of Secondary Batteries," p. 48).

Several authors have simply assumed, with no experimental evidence whatever, that hydrogen is occluded by spongy lead, or with evidence that cannot be regarded as trustworthy. Thus Drzewiecki (*La Lumière Electrique*, xxxv., p. 290) measured the potential difference between the two poles of his secondary battery, and found it to be 2·15 volts. He then measured the potential difference between each of the poles and a clean piece of lead, which he immersed in the electrolyte, and obtained 0·2 and 1·7 volt respectively. From these observations he concluded that the difference in behaviour of plain and reduced lead is due to the absorption of hydrogen by the latter. But it by no means follows that the difference is due to occluded hydrogen, and no facts have been brought to light which justify this conclusion, whilst many tend to prove the reverse.

Streintz has described (*Wiedemann's Annalen*, xxxviii., p. 355) an experiment which was supposed to prove the occlusion of hydrogen by reduced lead. If a completely charged cell is disconnected from the charging current and closely observed, bubbles of gas can be seen rising from both plates. These soon cease to rise from the peroxide plate, and Gladstone and Tribe have shown that they consist of oxygen, in this case, and are produced by the action of peroxide of hydrogen on peroxide of lead. The evolution of gas from the lead plates continues for weeks or months; it has been shown to be hydrogen, and herein Streintz finds an argument for the hypothesis that it is occluded by the lead, and afterwards slowly given off. The other possibility, namely, that it is produced by the action of dilute sulphuric acid on spongy lead, he rejects.

Now Thomson (*Thermochem-Untersuchungen*, iii., p. 335) has shown that lead belongs to that class of metals which decomposes water. And Gladstone and Hibbert (*Phil. Mag.*, August, 1890, and January, 1891) have found that in this experiment of Streintz's, sulphate of lead is formed; this he did not believe. Hence the hydrogen which is given off from the reduced lead is, without doubt, one of the products of the action of lead on dilute sulphuric acid, lead sulphate being formed at the same time.

This view has been confirmed by Cantor (*vide Monatshefte für Chemie*, xi., p. 444). Further, by means of a weighed cell in which the peroxide plate was replaced by a platinum electrode, he succeeded in showing that no hydrogen was occluded by the lead.

Thoma has shown that iron wire occludes ten times its volume of hydrogen at the ordinary temperature (*vide Zeit. für Phys. Chem.*, iii., 91), and according to the experiments of Billàti and Lussana (*Atti. R. Ist. Ven.*, i., series vii., p. 1,173), this gas diffuses through an iron plate which is used as the negative electrode on electrolysing dilute sulphuric acid. The method employed in this demonstration has been verified by Dr. Shields, and then applied to the case of lead; but he was unable to discover that this metal behaved like iron and occluded hydrogen gas.

On applying the method which Helmholtz and Root (*vide Monatsber. d. Berl. Acad. d. Wiss.*, 1876, p. 217), employed to show the occlusion of hydrogen by platinum to lead, Dr. Shields could only obtain a negative result.

The rate at which the potential difference between a polarised plate and a non-polarisable electrode falls off, affords another method for investigating whether a given metal occludes hydrogen or not. Dr. Shields adopted this method successfully. The metal to be examined was dipped into a vessel of water slightly acidulated with sulphuric acid, and the potential difference between it and amalgamated zinc in a solution of zinc sulphate measured. It was found that the measurement could not, in general, be made at once, as differences amounting to several hundredths of a volt were frequently observed; after about 20 or 30 minutes, however, the readings became constant. A platinum plate, acting as an anode, was then placed in the liquid, and the metal under examination polarised for an hour—in some cases for three or four hours—and the current interrupted. Measurements of the potential difference between the various metals examined and zinc in a solution of zinc sulphate, were made at the moment of breaking the battery circuit, and afterwards at frequent intervals, with Prof. Ostwald's modification of the capillary electrometer, and a suitable compensating apparatus.

A great many of the results obtained by Dr. Shields are arranged in the form of a table in his paper in the *Chemical News*. A cursory examination of these results shows that the substances examined may be divided into two groups.

1. That in which the potential difference falls off very slowly.

2. That in which the original potential difference is regained after a few minutes.

And these two groups, leaving carbon out of consideration, contain respectively metals which do, and those which do not occlude hydrogen.

When hydrogen occurs only superficially on a metal it quickly becomes oxidised, and the difference of potential due to it rapidly disappears; but when the hydrogen has entered into association with the metal, this process of oxidation occupies a much longer time, owing probably to diffusion, and consequently the original potential difference is regained only after the lapse of several hours.

Lead, then, belongs to that group of metals which does not occlude hydrogen, according to these researches of Dr. Shields, and as all the other evidence is in agreement with this fact, we must reject the hypothesis which is sometimes advanced in order to bridge over difficulties in the theory of the secondary battery, namely, that hydrogen is occluded by lead, and plays an important part in the chemistry of secondary batteries.

ELECTRICITY IN THE MANUFACTURE OF CELLULOID.

CELLULOID is a frank forgery of many of the auxiliaries of civilised life; its existence depends on the closeness of its resemblance to that which is scarce, and, in consequence, costly. The methods which are necessary to produce so close a resemblance to the real article cannot be followed out without considerable cost, and it is necessary to bear in mind that the cheapness of really good articles in celluloid is only relative to the value of those that are imitated. Of these latter, perhaps, ivory is the most important, and the decline in the supply necessarily tells heavily in this department of the imitative industry; and certainly no better substitute than celluloid has yet been found. Besides ivory, such substances as tortoiseshell, coral, linen, amber, &c., can be so closely imitated by celluloid that only experts can detect the difference.

Celluloid is beginning to take some part in the minor appliances of electrical engineering, *e.g.*, in the fittings of secondary batteries. Here the substance merely professes to be what it actually is.

It will scarcely be suspected that in the preparation of the cellulose, which forms the principal ingredient of "Parkesine" and other forms of celluloid, electrolysis plays an important part. The process employed is known as Hermite's electro-chemical process of bleaching, which is also coming into use in the manufacture of paper, &c. It is chiefly used in France, and was mentioned a few weeks ago in a paper read at the Philosophical Institution at Edinburgh by Mr. Walter Hogben, but as our readers have for some years past been familiar with it there is no necessity to dilate upon it further.

Such, then, is the part which electricity plays in the manufacture of this remarkable material; the rest of the process is chiefly of a more strictly chemical nature. As regards the colourings and markings which are imparted to celluloid in order to complete its resemblance to the substances imitated, it is sufficient to say that they are the results of elaborate experiments and processes, which are jealously safe-guarded as secrets of the industry.

Electric Discharge Experiments.

SEVERAL beautiful experiments were exhibited by Prof. Thomson at a meeting of the Philosophical Society (Cambridge) a few weeks ago which may be briefly noticed. Bulbs were used without electrodes, and by means of them it was demonstrated that as the density of the gas which they contained is varied, the colour of the discharge also varies. Variations in the intensity of the discharge also produce variations in the colour of the discharge. At very low pressures the gases contained in bulbs which have no electrodes are unable to act as an electro-magnetic screen, although they possess this property when they are at high pressures. Prof. Thomson illustrated the laws which govern the absorption of energy by conductors placed near rapidly alternating currents by experiments which showed that there was a much greater absorption of energy by small pieces of tin foil than by large masses of brass or copper.

The Electric Spark Spectra of Gallium.

A MEMOIR was recently communicated to the Paris Academy of Science by Mons. Lecoq de Boisbaudran on the spark spectra of gallium, which described the curious changes which the spectrum of this element undergoes if the nature of the spark is caused to vary. When sparks from a large induction coil play upon the surface of gallium chloride, the spectrum yielded consists of two characteristic violet lines, and a wide nebulous band in the green. A much more complex spectrum is obtained when the same coil is used with a condenser and the sparks are allowed to play upon metallic gallium; from this spectrum the band in the green is absent, but the violet lines remain unaffected in intensity. When a *small* induction coil is employed two other violet lines make their appearance in the spectra when no condenser is employed, but one of

them suffers considerably in intensity if a condenser is introduced, whilst two other new lines make their appearance. The wave-lengths and characters of all the lines observed under these conditions are stated in detail in *Comptes Rendus*, No. 14, Vol. cxiv., pp. 815—819, and tabular views of the rays obtained are given. Mons. Lecoq de Boisbaudran remarks, in conclusion: "We see what curious changes the spectrum of gallium undergoes if the nature of the spark is caused to vary. As analogous changes are produced in a more or less remarkable manner with almost all substances, it is very necessary to define the conditions under which electric spectra have been obtained."

Some Physiological Effects of Electricity.

The quack gets hold of a battery or a belt and at once proclaims that he can grapple with all the evils that escaped from Pandora's wonderful box. With a little sympathetic faith on the part of the patient the "specialist" will cure him of any of the ills that flesh is heir to. But how does the scientist approach the subject of electricity and human ailments? We can illustrate this question by reference to a recent research reported in the proceedings of one of the learned societies in Germany. Dr. Schweizer has been investigating the behaviour of spermatozoa towards electric currents, believing that before we can satisfactorily hypothecate as to the human organism we must understand the action of electricity in the elementary cells. He observed that only in a few cases did these cells move against the current, and that the position they assumed in parallel rows with the heads turned towards the kathode was not in any way a result of their vitality. Thus the results appeared to be somewhat negative. But true scientists will accumulate such results by laborious research and by-and-by generalise from them; the quack knows better than to "waste dollars in such unremunerative efforts." He sees the public waiting to be belted, and at once, without any research or humbug of that kind, announces himself the great exponent of medical electricity. "He takes their guineas and they gets his belts."

Consulting Engineers and Electric Lighting Specifications.

Complaints have reached us respecting a method adopted by the consulting engineer to a West End club of inviting electric light contractors to tender for the installation. The cables and wires must be ordered from one company alone, and cut-outs, switches, wall plugs or sockets, flexible cords, main switches, lampholders and key sockets from another, but the real bone of contention appears to lie in the lampholders, which are of the Edison-Swan pattern. These are manufactured by, say, the firms of A, B and C, and bear the respective makers' distinguishing marks, yet contractors are obliged to deal with A only for their goods, although it is possible that B or C might supply them on more favourable terms. We do not know that this need be considered a very great hardship as all the contractors are placed on the same footing, but it seems to give rise to the belief that the consulting engineer has an interest in certain quarters. Whether this is so or not in the particular case brought to our notice we are unable to say, but that some consulting engineers have taken, and still take, in addition to their just fees, commission from contractors and also from those whose materials are specified is unhappily only too true, and any clauses in specifications likely to engender the feeling that such practices are common are to be strongly condemned.

The Framing of Specifications.

In the same specification to which we allude above, we notice a clause, "Number of ampères on each circuit." "Not more than ten 16-C.P. lamps of 100 volts, or 20 8-C.P. lamps of 100 volts, will be allowed on any circuit, making 3 and 6 ampères per circuit, respectively." Now, how on earth does the expert manage to get the 3-ampére circuit in? And in the general instructions we notice that *no drop* of E.M.F. will be allowed at any point. But perhaps the consulting engineer has managed to dispose his circuits in such a manner that the small consideration of resistance is dispensed with!

Altruistic Effects of Electric Power.

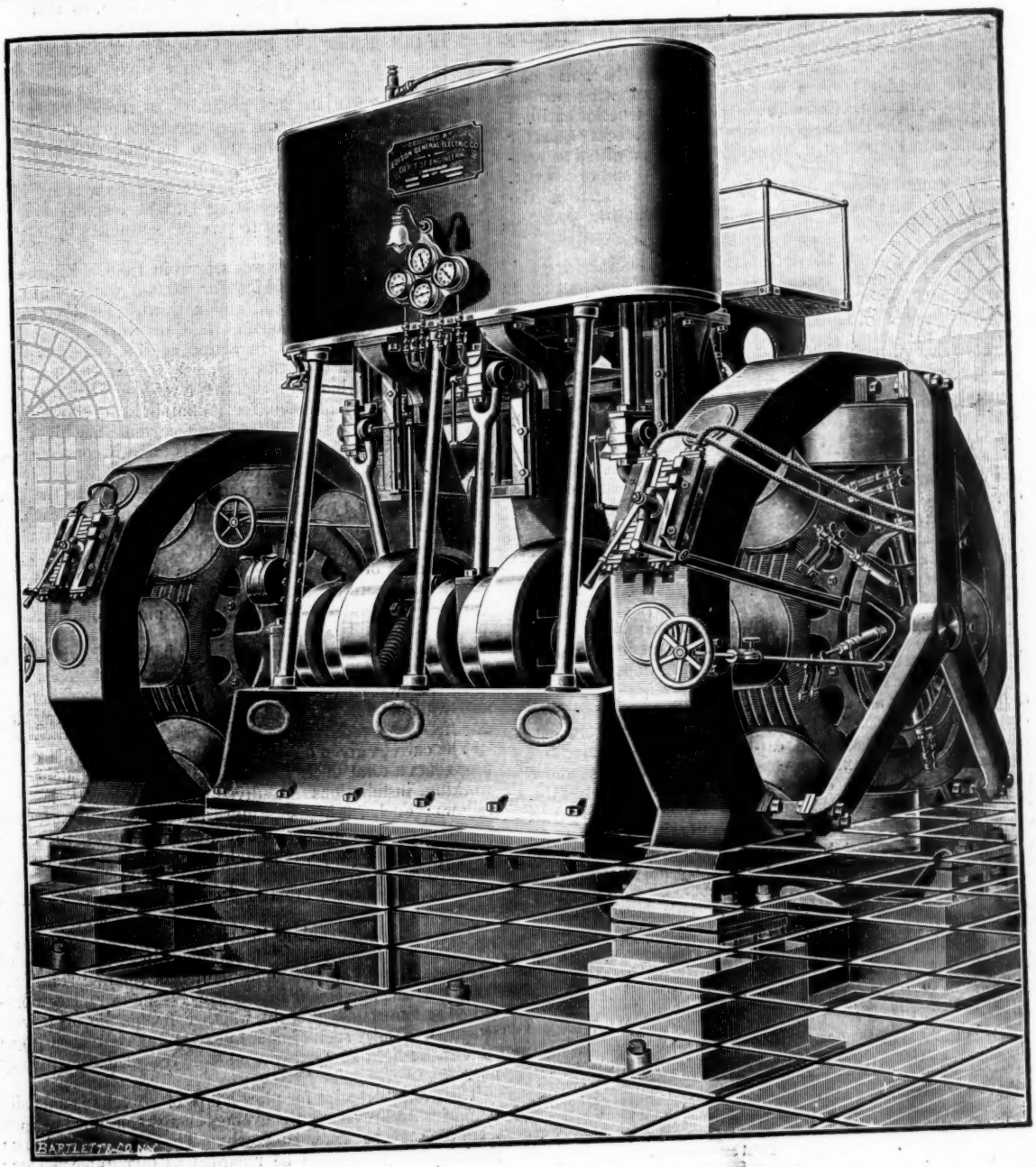
It was said a short time ago by a well-known writer that "though the future political economy may not be built from him directly, yet it will be rather with Ruskin's earth than with Ricardo's straw that its bricks for building shall be made." This brickmaking is to-day the result of our highest refinement in the manufacture and application of machinery; it may not be apparent to the economist, but to the student of Ruskin who is at the same time surrounded by the hopes and aims of the workshop the ultimate result seems clear. Millions feel the enslaving powers of the modern methods of production, and some there are who feel despair; others, seeing more clearly, feel that Ruskin's best thoughts are being developed in spite of the hindrances. Writing in this strain in the *Engineering Magazine* (New York), Dr. Perrine referred to recent achievements in the distribution of power. This great boon to mankind is full of beneficent effects that are perhaps scarcely suspected by many who enjoy them. And it seems strange indeed if, when the introduction of power enslaves, its higher application should emancipate, and if Ruskin's antipathy to machinery should be dispelled by its higher refinements. At the International Congress of Electricians held at Paris, in 1881, it may be remembered that Mons. Denayrouse earned the plaudits of the assembly by the assertion that the introduction of electricity would tend to elevate the workers' position, and to destroy the "great slave dens of factories." Wherever you meet the applications of electricity you will see a revolution in methods and a change in processes, always tending to greater healthfulness of operation and ease of work. For example, the smith, covered with grime, noisily welding a bar of metal is to-day excelled by the great electric forge heating the bar internally and forcing its ends together by pressure, so easy to manipulate that it could almost be controlled by a child; and again, instead of the copper smelting furnace, devastating the country for miles with its noisome gases, there is the electrolytic bath; while paper and linen are being made white as snow by means of electro-bleaching and our fair streams are to be no longer contaminated by refuse chemicals. Even the great smoke demon will soon have to hide its diminished head if Prof. Lodge succeeds in applying certain experimental facts with which our readers are familiar. So we have moved till we seem to see the time not far distant when even Ruskin himself could not ask for a nearer approach to his ideal of a workshop. With our powers consolidated and operations cleansed we may again "take joy and pleasure in the streams and breezes of England." Prof. Perrine's article is very suggestive as well as being speculative. Perhaps some will consider that he rather unnecessarily drags Ruskin into economics. That may or may not be now, but if we allow the "scientific imagination" a little play, this dream of the effects of the subdivision of power does seem to belong to the possible. At present, however, such propositions apply to only a very narrow fringe of our industries, and it is difficult to see how, looking at the matter practically, the division and distribution of motive power is likely to much influence the causes that have produced the factory system.

THE EDISON TRIPLE EXPANSION ENGINE AND MULTIPOLAR GENERATORS.

WE are indebted to the courtesy of the Edison General Electric Company, of New York, for the following :—

One of the most serious problems that to-day confronts the management of electric illuminating companies in large cities, is the cost of the land necessary to accommodate the large station buildings. When land costs $1,000 and upward a foot front, every square foot of ground space that can be saved materially reduces the necessary investment of the company. Recognising this fact, the Edison General Electric Company have recently brought out a new line of central station units, consisting of two multipolar dynamos coupled direct, one on either side to a triple expansion engine, and ranging in capacity from 100 to 1,500 indicated horse-power. This combination does away with all belting and countershafting, and thus secures an increase of efficiency and a great saving of floor space—two most important factors in central station practice.

The important features of this type of generator are given in the following description, which will undoubtedly prove of interest to central station managers.



THE GENERATOR.

The saving of floor space being one of the chief objects, the necessity of coupling the generator directly to the engine naturally suggests itself ; but as the armature of the bipolar generator now in general use must, of necessity, be run at a comparatively higher number of revolutions per minute, it is evident that unless a special engine is employed, another design of generator is called for.

The multipolar generator is peculiarly adapted to this purpose, as it may be designed to generate any desired electrical output at an armature speed corresponding to that of a slow speed engine. This type presents the additional advantages of requiring but small floor space, of being able to withstand sudden variations of the load, and of carrying heavy loads continuously without danger of overheating.

The armature is of the Gramme ring type, of very simple construction, it is built up of ⊏ shaped copper strips, which are slipped (in a single layer) over the laminated wrought iron core, the upper end of one being connected with

the lower end of the adjoining loop by a copper bar of corresponding thickness, these bars acting as the segments of the commutator. The number of brushes correspond to the number of poles of the generator, and it is found that the large current output can be divided among these brushes much more conveniently than if only one set of brushes were used to carry the whole current generated. The mechanical device for controlling these brushes allows of their being operated together, so that when once adjusted the whole can be handled as though but one set were used.

The field coils are wound on separate spools, which are slipped over the field magnets; these field magnets are then inserted in an annular or polygonal field frame, mounted on the bed-plate of the engine. The bed-plate being heavy and massive, and of special design, perfect alignment and rigidity of the field frame with relation to the engine is secured.

The increased diameter of the armature in the multipolar type of machine gives a very large heat radiating surface. This point, in connection with the special construction outlined above, allows the Edison generators to maintain heavy loads for periods of any duration, a factor that will be admitted as eminently desirable in central stations where such conditions exist.

The armatures are mounted directly on both ends of the crank shaft, and act as the flywheels of the engine.

THE ENGINE.

The engine is of the triple-compound 3-crank inverted cylinder, automatic condensing type, well proportioned throughout, having large wearing surface which can be easily adjusted. The bedplate to which the main bearing boxes of the crank shaft are cast is strong, and is firmly bolted to a massive foundation box which also carries the dynamo frames—thus perfect rigidity between engine and generator is ensured. The crank shaft is of forged steel, fitted with cast-iron balanced discs to which the crank pins are fitted. There are two bearings to each crank, and an additional large bearing on each end of the shaft to carry the armature. On the shaft are three eccentrics, each operated by its own independent governor, so that the point of cut-off in each cylinder is changed equally with the load, thus doing away with any tendency to race, in case the total load is at any time thrown off, or any accident happen. Strong cast iron columns carry the cylinders which are bolted together, and the engine made strong, compact, and well arranged; indeed these engines are almost fac-similes of the latest and most improved types at present in use on the finest ocean steamships, with necessary additions to render them as highly efficient for electric generating purposes as their prototypes are for marine work. They are calculated for the maximum efficiency point at about 12½ per cent. below the normal maximum capacity of the generator, and have a range to a maximum capacity of 20 per cent. above the normal maximum output of the generator at 160 lbs. initial pressure, and vacuum of 24 inches, thus allowing each engine, in case of an accident to the condensing apparatus, to operate the generator satisfactorily non-condensing. In addition to the many advantages already mentioned, these engines when connected to a suitable condenser, will reduce the consumption of fuel considerably. This is an item of vast importance in electric light stations, increasing their storage, boiler, and engine capacity. The compactness of this arrangement, as shown in the following table, prove the advantages to be gained by the use of the dynamos and engine thus combined.

COMPARATIVE FLOOR SPACE REQUIRED BY TWO GENERATORS AND ONE ENGINE.

Two bipolar generators belted to one high-speed engine.			Two multipolar generators coupled direct to one Edison triple expansion engine.		
Total capacity—two generators.		Minimum floor space in square feet.	Total capacity—two generators.		Minimum floor space in square feet.
K. W.	16 C.P. lamps.		K. W.	16 C.P. lamps.	
50	900	270	50	900	56
90	1,820	374	100	1,800	121
200	3,600	511	200	3,600	180
350	6,300	571	400	7,200	356

ELECTRIC LIGHTING AT TEMESVAR.

[FROM OUR OWN CORRESPONDENT.]

TEMESVAR is the first Hungarian city into which electric lighting from a central station has been introduced. It was in 1884 when the city resolved, instead of gas, as heretofore, to supply the public streets and squares with the electric light. The London Brush Company obtained the concession after a universal competition. The light was carried out with, altogether, 731 glow lamps of 16 normal candles each, introduced in series in groups of eight each, so that the installation worked with a tension of 2,100 volts.

In this manner the Brush Company supplied the public lighting, to which its activity was almost exclusively restricted for four years. But with this limited activity the undertaking was the less profitable, as the agreement with the city was founded on very moderate prices. The establishment resolved, therefore, to include private lighting in its circle of activity, and for this purpose, in addition to the existing machines for the series of glow lamps for the streets, to erect an alternating current installation and to distribute electric current to private consumers by means of transformers.

For this purpose there was set up in 1888 a Zipernowsky alternating current machine for 80,000 watts, which was soon succeeded by a second and a third. The transformers brought into use are also from the Ganz works.

There are at present in action at the Temesvar Works four Brush series dynamos each for 10 amperes and 2,100 volts, two of which are kept as a reserve, with two steam engines of 150 H.P. each, for public lighting; further, the three above-mentioned alternating current machines with their exciters. Of the former, one is directly connected with a 250 H.P. engine, whilst the two others are driven by two other engines of 150 H.P. by means of bands. In the boiler house there are two Cornish boilers of 150 H.P. each, and two Babcock and Wilcox boilers, each of 200 H.P. The boilers work at a pressure of eight atmospheres each. As the erection of a lofty chimney was not permitted by the municipal Board of Works, the requisite draught had to be supplied by means of a blast. A common condensation is provided for all the engines.

Aerial leads are used exclusively both for private and public lighting.

As regards this installation, the following working data are available for the period from July, 1891, to February, 1892.

The current given off from the works during this period represents a total energy of 392,055 kilowatt hours. The working installations are divisible per kilowatt hour as follows: Fuel, 7·9 kreuzers, lubricating oil, cotton waste, and materials for tightening, 0·38 kreuzer, charges for maintenance, 1·34 kreuzers, rent and taxes, 0·49 kreuzer, cost of management, direction, and insurance, 0·88 kreuzer. The total working charges are therefore 13·46 kreuzers per kilowatt hour.

The receipts for public lighting are 30, and for private lighting 36·4 kreuzers per kilowatt hour, in which is included the cost of replacing the glow-lamps, as the undertaking is bound by the agreement in the concession to replace worn-out glow lamps gratuitously, whether for public or private purposes. Under such circumstances the above-named prices for electric light at Temesvar must be regarded as extremely low.

The average receipt for glow lamps of 35 volts is annually 10 florins 45 kreuzers; the average energy consumed by such a lamp is 65·34 kilowatts yearly. The mean demand upon the lamps may therefore be regarded as favourable. There are at present 6,300 glow lamps in action.

Chicago Exhibition, 1893.—The Royal Commission announce that applications for space in the British Section can only be received up to Saturday, May 21st. Any applications received after that date will be filed, in case of any space becoming hereafter available, but will not be included in the first allotment.

THE "PILSEN" PORTRAIT PHOTOGRAPHERS' LAMP.

THIS apparatus consists of a ball and socket suspension, a large reflector, made of metal to give it strength, and a large current "Pilsen" arc lamp to feed at an angle (fig. 1). It has for its object the production of a perfectly diffused white light, which shines on the sitter from one direction, this direction being adjusted by the operator, who can with one hand swing the suspension and lamp round or up and down, the lamp and reflector being balanced and fixed on universal joints. The standard size takes 55—45 ampères at 47—55 volts. The lower carbon is the +, whose crater throws nearly all the light from the arc on to the dead white surface of the 4-feet reflector, from which it is scattered on to the sitter. The positive carbons is 20 mm. patent Pilsen carbon, and the negative 15 mm. solid carbon. The carbon holders are easily adjustable, and the lower one can be adjusted while the lamp is burning without any danger as regards shocks or sparks. The details of gripping and adjusting the carbons has been carefully worked out, as on the true centreing of the carbons depends largely the good burning of the lamp.

In large current lamps, especially those at an angle, the shapes of crater and point have a great deal to do with the noiseless and steady burning. This lamp burns noiselessly for hours when the shapes of carbons and arc

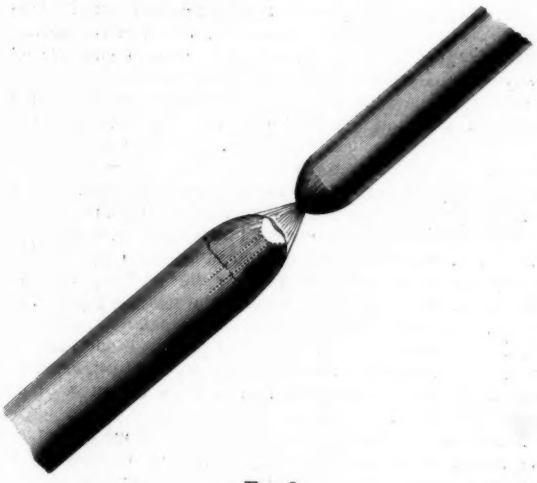


FIG. 2.

flame are somewhat as shown in fig. 2. The lamp, of course, like all arc lamps on incandescent circuits, has a resistance in series. They are made for 60—80-volt circuits and also for 100—115-volt circuits, adjustable or not, as required.

Several of the lamps are burning on supply companies' mains, both in London and in other cities, and others are fed by incandescent lamp dynamos, either compound or shunt wound, driven direct by gas or steam engines.

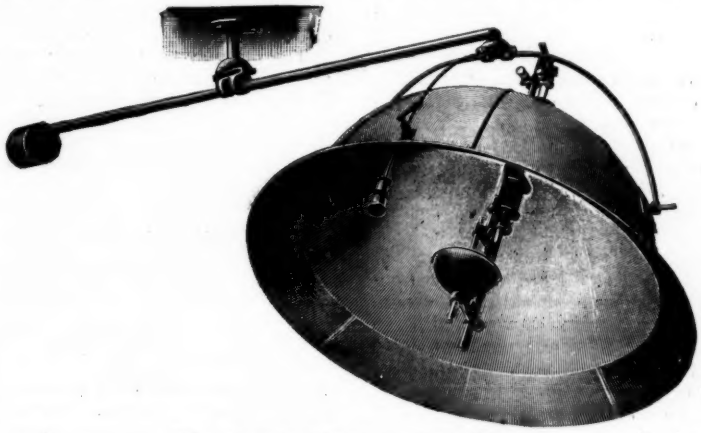


FIG. 1.—PILSEN PHOTOGRAPHERS' LAMP.

HOW DANGERS FROM ELECTRICITY IN EXPLOSIVES FACTORIES MAY BE AVOIDED.

IN a recent paper on the manufacture of explosives, to which we made reference in a leading article on May 6th, Mr. Oscar Guttmann, A.M.I.C.E., gave some interesting information concerning the dangers which arise through the development of electricity during certain stages of the processes. These dangers too frequently end in explosions, but it is satisfactory to find that they are being reduced in number and in effect every year. When the Explosives Act came into operation it certainly made a great stir amongst the manufacturers, but seldom has there been, on the whole, a wiser measure taken. If it be remembered that last year fatal accidents occurred only in one gunpowder factory, and that the mortality amongst the operatives in explosives works was not larger than that in all London, it will be agreed that the Act has been very beneficial, and that the inspectors who superintend the working of it are doing most useful service.

Whoever has read the reports of Her Majesty's inspectors of explosives, will have nearly invariably found more than one possible cause given to account for the accident. The real cause of the explosion has rarely been traced with certainty, but those who have studied these reports will have been astonished to find a power of generalisation displayed which has never yet failed to teach some sound moral for the benefit of those concerned.

An explosion may be defined as the sudden decomposition of a mechanical mixture or chemical compound into its components, whereby in a very short space of time a great pressure is developed. Such an explosion may be started by different means and they are by no means the same in every case. The causes are too frequently obscure, for the effects often destroy every trace of them. Sometimes ignition will start the decomposition, sometimes a shock, friction, an electric spark, vibration, sudden rise of temperature, &c.; but as a rule it is necessary, as Sir Frederick Abel has pointed out, that a certain amount of vibration of a distinct nature be generated as a result of either of these causes, in order to produce explosions.

It is not our province to deal with these causes seriatim, but one of them specially concerns students of the science of electricity, and it is well that electrical engineers should be acquainted with those electrical conditions which determine danger in explosives factories, as they may be called upon for opinions or advice.

Manufacturers of explosives are beginning to realise that some, at least, of the dangers they have to contend with are connected with the electrical properties of the substances handled; these properties are usually made manifest under the influence of such mechanical conditions as shock and friction, especially the latter. We will consider the chief dangers of this order which arise in the manufacture of gunpowder.

In making gunpowder sulphur is largely used. It is now generally ground before mixing it with the nitre and charcoal. Although by quick grinding a large amount of heat is de-

veloped, this is scarcely ever sufficient to fire the sulphur. But sulphur mills very often take fire, and, in Mr. Guttmann's opinion, the ignition is chiefly due to the well-known electrical qualities of sulphur which are made evident by the friction and heat produced during the grinding operations. A simple precaution can be taken against this danger, for copper wires may be arranged so as to carry away the electricity to earth as fast as it is generated. Manufacturers who have adopted this precaution have never had a sulphur mill fire since.

Another cause of danger, probably arising in a similar way, exists in the mixing drums where the ingredients are incorporated, and, indeed, in nearly all other powder machinery, for electricity is accumulated owing to the friction against the sulphur particles. Some years ago Mr. Guttmann advised the "earthing" of mixing mills, and he believes that the number of accidents has considerably diminished wherever his suggestion has been adopted.

One process in gunpowder making consists in the pressing of the damp powder meal by means of hydraulic machinery. In modern factories the meal is, as a rule, laid on an ebonite plate, spread out flat with a shovel, and another ebonite plate is placed on the top of it, and so on, layers of powder and ebonite alternating until the required height is reached. This method is much safer than the old roller press system, provided the presses are kept clean and the hydraulic ram is not allowed to fall too quickly.

But there is, again, the danger of electricity, which in this case especially must not be under-rated. The charge of a powder-cake press with ebonite plates can, says Mr. Guttmann, practically be considered as an electric pile, and a large amount of friction or electric influence from outside may cause a sufficient electric charge to give off sparks. Several undisputed cases of this have been known, and the following instance occurred at a large continental factory. The workman, having just finished charging, opened the valve for the hydraulic pressure when he became aware of an approaching thunderstorm. According to his instructions he left the building, returning after he considered the storm to have passed away; but when he resumed work and began to discharge the press it exploded. The man died, but stated upon his death that in undoing the cakes a spark of four inches in length came on his finger.

Evidently it is advisable to take great precautions in using ebonite. It is a very convenient material, being tough, of smooth surface, hard, and not subject to much wear, yet sufficiently elastic; it is therefore largely used for plates in the powder-cake presses, for the lining of hoppers in granulating, sifting machines, &c., but great care must be taken that no electricity accumulates, even under unfavourable circumstances.

Another source of danger from friction occurs in making gunpowder during the glazing, rounding, and sieving operations. The powder is subjected to a constant rubbing of its particles against each other; and during the glazing, especially, there is danger of electricity accumulating, therefore precautions should be taken in order to convey away any charge that may accumulate in the glazing barrels.

The manufacture of nitro-compounds is not perhaps attended with so much danger from electrical causes as that of gunpowder, but one source is apt to be overlooked. Gun-cotton is usually dried by means of hot air. If a current of hot air passes over a layer of this substance the cotton may become strongly electrified. Mr. Guttmann believes that most, if not all, the fires in gun-cotton drying houses are due to a neglect to carry away this electricity.

Electric alarum thermometers should be stationed wherever there is a danger of the temperature rising too high.

No stronger evidence of the safety of electric lighting installations can be afforded than the fact that a great many explosives factories are now being lit by electricity. We commend this to those holders of gas shares who every now and then raise a great outcry about the dangers of electric lighting. But it is obvious that in a building wherein the preparation of inflammable or highly explosive substances is carried on, very special care should be taken in order to avoid even the smallest risk. Mr. Guttmann in his paper on the manufacture of explosives, stated from his own experience that it is highly important that suitable lightning conductors should be attached to the circuit.

Overhead electric light wires should be avoided, for cases have been known where lightning has struck into wires carried in this way.

The wires should always enter a building from opposite sides, so that danger from short circuiting may be reduced to a minimum, and no joint or switch should be allowed inside the building, for the air within is often highly charged with minute particles of the explosives which are being made, and is thus rendered easily explosive: even a small spark will determine decomposition under such circumstances.

The lamps should invariably be surrounded by a large tightly fitting glass globe which allows sufficient radiation of the heat. For although the heat on the outside of a lamp is rarely higher than 120°, yet if a lamp be covered with a layer of explosive dust and the heat cannot radiate, there will be such an accumulation of heat that serious accidents may occur.

Suitable "cut outs" should be introduced so that the whole of the plant is placed out of circuit if ever the current becomes excessive.

Some special regulations have recently been issued by the Home Office in regard to electric lighting in explosives works, but so short a time has elapsed since their introduction, that their effect can scarcely yet be appreciated, and it would be scarcely fair or even possible, perhaps, to criticise them.

The question of the proper protection of explosives factories from lighting was dealt with in a previous paper, *vide* ELECTRICAL REVIEW, May 6th.

AN ANTIDOTE FOR MERCURIAL POISONING.

By LEGH S. POWELL.

MANY improvements and novelties are recorded in this and other technical journals. The majority of them naturally relate to contrivances, methods, &c., which are designed to a considerable extent with the object of deriving pecuniary benefit. The case is more rarely met with in which the matter brought forward appertains to progress whereby the cause of humanity alone is sought to be benefited and where pecuniary considerations are wholly absent.

The subject of the present article relates to an improvement, or, more correctly speaking, the institution of a practice of the latter kind, and it is one so effective and easily adopted that it is worthy of extensive notice. It is, moreover, to be hoped that the preventive measure to be described will find its way into the many existing (and future) incandescent lamp factories, and some other industries such in which mercury is extensively employed, in case some equally effective means is not already in force.

Mercury and its compounds are universally known to have an injurious influence on on the human system, and the evil effects are, unfortunately, only too familiar to persons intimately connected with the pump rooms of lamp factories. The shake, the shortness of breath, the sickening pallor, the listless, semi-stupefaction of the individual, and other less striking symptoms to which afflicted persons become subject, are sights exceedingly revolting and trying to witness, and cannot but arouse compassion even from the most callous minded spectator.

Much may be done and much has been done to improve the health of the workmen by means of ventilation and improved machinery and pumps, but it is doubtful whether by such means alone the difficulty can be efficiently and practically met. Slight cases of mercurial poisoning are usually quickly and effectively cured by change of air, or of work, but a serious case may end fatally, as the writer knows. This obvious and effective remedy of change of air, or of work, is not one, however, which always commends itself either to employer or employee as the most convenient course imaginable, and there is therefore room for other and more efficient means.

Monsieur Paul Triquet, of the firm of Pulsford, Triquet & Co., Paris (who are extensive manufacturers of incandescent lamps), informs the writer that some three or four years ago he became salivated whilst experimenting with mercury pumps, and he cured himself completely by means of small doses of iodide of potassium, dissolved in milk. M. Triquet next administered similar doses to some workmen in a lamp factory he was then connected with and who were likewise affected with mercury, with the result that they also completely recovered. In his present factory, which has been in full work for considerably over a year, doses of the same salt have been continuously administered to the workmen engaged in the pump room from the commencement, and not a single case of salivation has broken out throughout this period. Further, there have been instances where men from other factories have been taken on, who, on entering, exhibited the characteristic signs of mercurial poisoning, and who completely recovered in due course.

These facts speak for themselves; comment is superfluous.

The daily dose supplied by the firm to each man is ·25 gramme of the crystallised salt, dissolved in about 400cc. of milk. Probably it would be a little more scientific to increase the dose in summer when cases of salivation are much more frequent, and to diminish it during the cooler months of the year. But this point has little significance in a case where actual practice fully answers every requirement.

The precise manner in which iodide of potassium acts on the system is a problem to be dealt with by medical experts. Generally speaking, however, it is probable that one or more of the iodides of mercury are formed, and that such compound or compounds being appreciably soluble in water, especially in presence of iodide of potassium, become removed from the system in the usual manner.

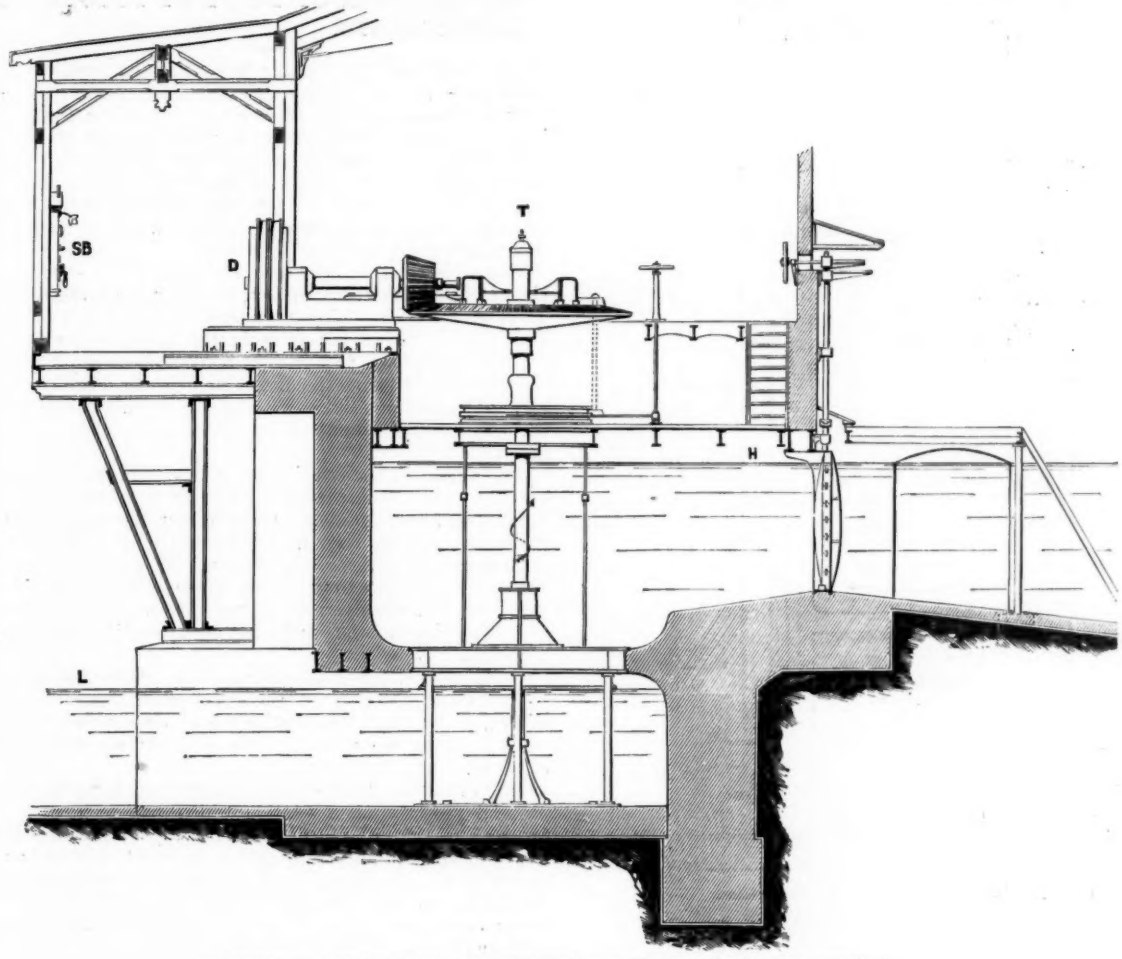
It is not known to the writer, or to any of those with whom he has spoken on the subject, whether the same or a similar practice to that described is in use in other factories; but however this may be it is certainly not generally known, still less employed. It must be conceded on all sides that very great credit is due to Monsieur Triquet for having originated and put into practice such a simple and effective means of curing and of preventing a distressing malady which accompanies the necessary use of mercury.

MULTIPHASE TRANSMISSION AND DISTRIBUTION OF ELECTRIC ENERGY.

By A. RECKENZAUN.

(*Continued from page* 553.)

At present there are two turbines and two dynamos in operation at Lauffen, the third set is in course of construction, and is mainly intended as a reserve set. The turbines are of the vertical type, made by the Maschinenfabrik Geiss-



B, Switchboard; D, 200 kw. Dynamo; T, 300 H.P. Turbine; H, High water level; L, Low water level

FIG. 2.

lingen; they run at 35 revolutions per minute, and drive the three-phase generators through bevil gearing. The generators, one of which supplied the current for the Frankfort-Lauffen plant during the exhibition, are too well known to require detailed description. Each makes 150 revolutions per minute when giving 4,000 amperes with 50 volts. The machine consists of a stationary armature with solid copper bars, and a rotating field with a single bobbin and 32 poles, made to the designs of Mr. C. E. L. Brown. Fig. 2 shows a vertical section through one set of turbine and generator.

The transformers, unlike those used during the exhibition, are not enclosed in oil tanks. They are placed into a separate transformer house, shown in fig. 3, which also contains the necessary safety cut-outs. By means of this superposed ar-

rangement, it is easy to get at every part of the transformers and their connections to the transmission leads and safety devices. The Government of Wurtemburg has been very exacting in the matter of safety appliances, especially those placed at the village of Southeim, which lies half-way between Lauffen and Heilbronn. At Southeim is a 20 kilowatt transformer station for local consumption, containing the transformer in a locked-up room, and a switchboard with instruments and safety devices, as, also, a telephone. The telephone circuit runs on the same poles as the transmission leads, and is only about 28 inches below them. It serves the double purpose of telephonic communication and as pilot wires for taking measurements. The telephones are said to work admirably in fair

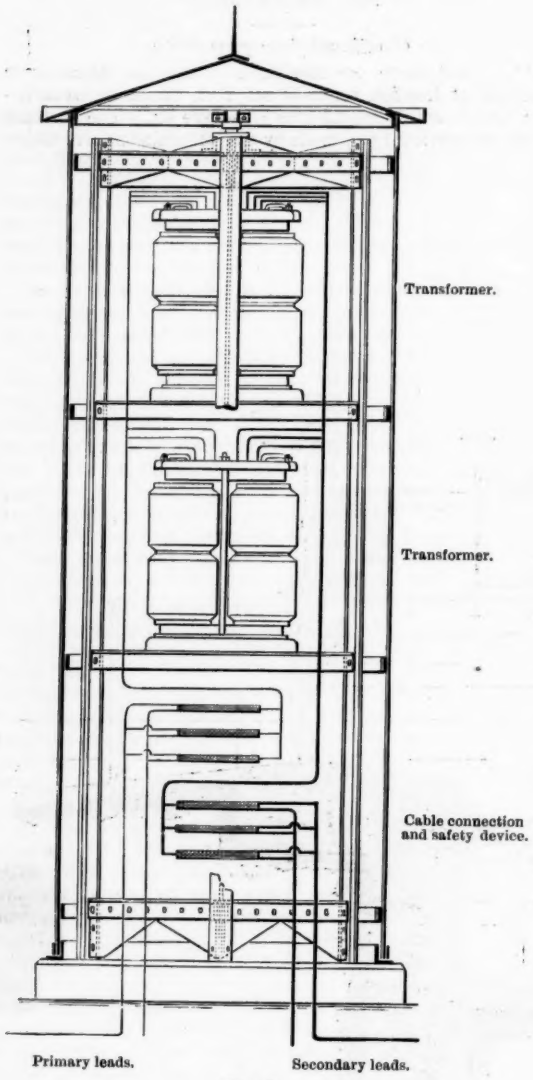


FIG 3.

weather, and that only during very strong winds can any disturbance be observed. Messrs. Reiner, of Munich, have provided transmitters and receivers of a special design to work in proximity of the "Drehstrom" circuits with the least amount of inconvenience to the users of the telephone line. During a storm, when the overhead wires assume varying positions relatively to each other, sufficient induction is set up to make telephoning difficult. Animated discussions have recently taken place in Germany between the postal authorities and electric light engineers on the subject of interference with telephones and telegraphs. In fact special laws are being passed to protect the Government from disturbances created by the increasing use of heavy currents for purposes of transmission of electric energy. To judge by the fierce arguments at the meetings of the German electrical societies one is bound to come to the conclusion that there are two opposing parties. One, a conservative party consisting of telegraph and telephone engineers backed by Government officials, who are called "Schwachstrom" (weak current) engineers, and the progressive party, composed of "Starkstrom" (strong current) engineers.

The consumers at Heilbronn are supplied with electricity meters devised for three-phase circuits by Dr. Aron. A special kind of arc lamp, of which either two or three run in series, has been constructed by Messrs. Körting and Mathiesen. Motors of from 2 to 15 H.P. capacity are being made by the Allgemeine Elektricitäts Gesellschaft. These motors are self starting, run at constant speed with varying loads, have no commutators, and are reversible. With the exception of charging accumulators, this multiphase system has the combined advantages of the alternating and the continuous current systems without the disadvantages of either.

(To be continued.)

THE DETERMINATION OF ELECTROLYTIC DISSOCIATION OF SALTS BY SOLUBILITY EXPERIMENTS.

DURING the past few years a great deal of research has taken place in this country and on the Continent with a view to determining what effect one salt exerts on the solubility of another; but although a mass of results has been accumulated, the information has been for the most part purely empirical. Investigators were beginning to tire of such barren work, when Nernst came forward and showed that the electrolytic dissociation theory offered an explanation of this phenomenon of solutions.

From this point we have carefully followed up every new piece of research on this subject, as our readers are aware. There is scarcely anything of importance that has not been dealt with briefly or otherwise in the pages of the ELECTRICAL REVIEW, for it is in this borderland of physics and chemistry that the more speculative amongst our scientists look forward to finding the solution of many obscure problems—that of chemical affinity being by no means the least of them.

The validity of Nernst's theory has been warmly supported by many of his fellow workers in Germany. Noyes, for example, has subjected it to an exhaustive series of experiments, and has been unable to find it wanting. True some discrepancies have been observed by others. Noyes is disposed to attribute to the incorrectness of the dissociation values used in the calculations, that is, to the assumption that dissociation and molecular conductivity are proportional.

Now, just as the solubility of one salt in the presence of another can be calculated if the values of the dissociation be known, so conversely can the degree of dissociation be determined from the values of the solubility experimentally obtained.

Up to the present time electrical conductivity is the only physical property of a solution which has been used to furnish a measure of the dissociation of the substance dissolved in it. Although this method, as used by Ostwald and others, gives reliable results in the case of organic acids, Noyes believes that it cannot be depended on in the case of better conductors, such as most metallic salts and strong acids and bases.

These considerations have led Noyes to study the dissociation of the chlorides of various metals by methods depending on their solubility. He arrives at the following results, which are given in the course of a paper in the *Technology Quarterly*.

The effects of eleven different chlorides on the solubility of thallous chloride was investigated, each in four distinct concentrations, and the dissociation of each was calculated from the solubility effect. The three alkali-metal chlorides, potassium, sodium, and ammonium, were found to be equally dissociated, their dissociation increasing from 65 per cent. in the case of a solution of 0·2 normal strength, to 89 per cent. at 0·03 normal. The dissociation of hydrochloric acid was slightly greater (73 per cent. to 89 per cent.). With a single exception all the bivalent metal chlorides investigated, namely, manganese, calcium, barium, zinc,

magnesium, and copper proved, like the univalent metal chlorides, to be equally dissociated. Their dissociation is about 5 per cent. less than that of the alkali chlorides. Cadmium chloride forms the exception spoken of, its dissociation being 33, 43, 53, and 60 per cent., as against 62, 69, 78, and 82 in the case of solutions of the other chlorides of corresponding concentration. The results were confirmed by corresponding experiments with lead chloride.

JACOBI WORKS AN ELECTRIC MOTOR IN THE YEAR 1870 BY MEANS OF A SECONDARY BATTERY.

BY A. M. TANNER.

THE recently decided Lane-Fox suit involving an English patent granted in the year 1878 for the distribution of electric currents by secondary batteries brought to light some instances where secondary batteries were used prior to the date of said patent for industrial or practical purposes; for example it was shown that Achard used a secondary battery for working electric car brakes and that Planté proposed such batteries in connection with gas lighting devices. These references, however, were held by the plaintiffs in the suit to be for periodically working batteries only, having no pertinent bearing upon the Lane-Fox patent. It therefore becomes of interest to make known a reference where a secondary battery was used continuously for driving an electric motor.

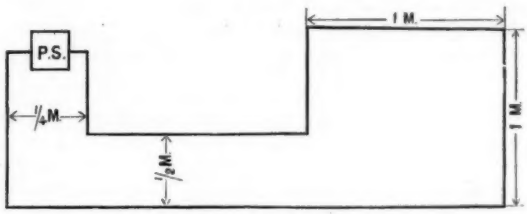
Jacobi, the celebrated pioneer in electric motor work, has an article in the *Melanges Physiques et Chimiques of the St. Petersburg Academy of Sciences*, Vol. viii., year 1870, copied in Poggendorff's *Annalen der Physik and Chemie*, Vol. 150, p. 583, "on the use of secondary or polarisation batteries with electric motors." In these articles it is stated that "the kind of galvanic batteries to be used with electro-magnetic motors is of vital importance in the practical working of these motors. In the first place such a battery must be as constant as possible and possess a high electromotive force, because the electro-magnets of the motor used by me are wound with thin wire, for which reason a battery is required with the elements arranged in series." The description then states that a Planté battery is employed, formed of 50 elements arranged in two groups of 25 elements each, which are alternately charged and discharged, the arrangement being such, that when the first group of 25 elements are placed in series in order to furnish current to the electric-motor, the other 25 elements are coupled in parallel in order to be charged. The description continues, and states that after a certain time a change is automatically effected by means of a Poggendorff switch (Wippe) and the first group of elements of the battery is cut out of the motor circuit and brought into parallel in order to be charged, and simultaneously the elements of the second group of the battery are thrown into series for furnishing current to the electric motor. The description further states that the primary battery used for charging the secondary battery is either composed of two large plate Bunsen or Grove elements or four Daniells cells.

ECONOMY IN ARC LIGHT WIRING.*

BY U. B. ROMMEL.

IN taking exception to my discussion of his paper on "Economy in Arc Light Wiring," Mr. Sharpsteen still labours under the delusion that all of our towns in which plants of from 50 to 80 lamps are in operation are necessarily densely populated and have but two or three streets which run parallel to each other, and very close together. Under these favourable circumstances, I admit the value of the proposed system of wiring; but unluckily for the engineers in charge of such construction work, they do not often meet with such a favourable arrangement. It is true that the majority of such towns have but two or three business streets but not often located to advantage.

I give below a sketch of the business streets of one of these towns, where I was called upon to construct an arc circuit for 50 lights. About 20 of these were street lights and the remainder commercials. It was necessary for us to have the line on every street shown, and to loop from one street to the other, in order to keep the commercials (which were about evenly divided) in rotation, we certainly would



P S, Power station; M, Mile and parts of mile.

have consumed at least as much, if not more, wire by Mr. Sharpsteen's method than by running two complete circuits, and a great many more poles, which it would be necessary to place on side streets where they would be of no benefit for the use of other wires. It must be remembered that the original cost of poles and setting enters into consideration as a matter of economy, as well as the amount of wire consumed.

I have by no means lost sight of the fact that the line can leave the main street and return several blocks below or above; but it is doubtful if this is advisable, as electric light superintendents are well aware of the fact of the instability of commercial arc lights in our smaller towns; these lamps often being in service but several months, when they are removed to another customer. If the plan in question is followed, the poles and wire constituting the loop for this lamp are a dead loss, unless a consumer be found near the same place, and the advantage of having the line the entire length of these streets, when a possible future customer can be immediately given service, is easily seen. The continual planting of poles and stringing of loops under the proposed plan is by no means inexpensive, and will often amount to more than the possible saving in wire. This system of wiring certainly has its value in some instances, but it should by no means be considered as a standard for all of our smaller towns.

Mr. Sharpsteen requests that I mention the arc lamp of which I said the excess current passing through the magnet coils after the point of cut-out has been reached was detrimental to the coils and adjustment of the lamp. The lamp in question was the Thomson-Houston, which is no doubt more extensively used than any other in this country to-day. Any person familiar with this lamp will appreciate the difficulty experienced by allowing the lamp to cut itself out as mentioned; and will see the necessity of a short-circuiting switch, or some similar device, for the safety and good adjustment of their lamps, which, in other words, means economy and satisfactory service.

* New York *Electrical Engineer*. Also ELECTRICAL REVIEW for April 8th, 15th, and 29th.

REVIEWS.

Telephones, their Connections and Circuits. By G. and M. BINSWANGER. London: The General Electric Company, Limited.

This is a capital little book, a sort of time and labour saving appliance, inasmuch as there is very little reading required to obtain a large amount of information. Excellent diagrams, which the veriest tyro could decipher, show at a glance various methods of connecting up telephones with their necessary circuits. Even expert electricians are sometimes a little puzzled over the sundry terminals of telephonic apparatus, and waste time in thinking the connections out. With this handy book before them they can at once set to work and join up all the wires, batteries, &c., and feel perfectly certain that the thing will work. Besides showing all the im-

portant connections, there are useful hints on outdoor construction, and on finding out faults, with suggestions to remedy the same. Everybody owning or about to own a telephone, should be in possession of this useful little treatise. The price is exceedingly moderate, notwithstanding good paper, print and binding.

Curves, Tables and Simple Rules relating to Copper Conductors, for Electrical Engineers. By E. W. Lancaster. Birmingham: Fowler, Lancaster & Co., Limited; and Electrical Review, 22, Paternoster Row.

This is a small folding card of four pages. The curves show the relation between current, fall of potential, length of conductor and its gauge. Two diagrams show at a glance the cable required to carry a given current any distance, the fall of potential per 100 yards being specified. A third diagram shows at once the cable required to carry a given current, the fall of potential being fixed at 1 volt for any length up to 240 yards. The diagrams also show the current density in the conductor, in ampères per square inch of sectional area. A table gives the "current-carrying capacity in ampères at 1,000 ampères per square inch at a loss of 2·5 volts per 100 yards, as also the same at 800 ampères per square inch and a loss of 2 volts per 100 yards." This table also includes "Number of strands of S.W.G.," "Pounds per 100 yards without insulation," "Yards per pound without insulation," "Diameter of conductor in mils," "Resistance per 100 yards at 75° F. in ohms," "Yards per ohm." Altogether the production is a very useful and handy one.

NOTES.

The Production of Electricity by Living Bodies.—An ingenious and interesting experiment is described by M. D'Arsonval in a recent number of *La Lumière Electrique*, illustrating the action of an expanding or contracting muscle in producing an electric current. The apparatus consists of a length of India-rubber tubing, held vertically, and divided into a number of cells by small porous diaphragms; each of the cells so formed is filled with acidulated water and a small quantity of mercury. On pulling the tube so as to stretch it, the whole arrangement becomes an active battery, from which a current can be obtained.

The Magnetic Disturbances in February.—The extraordinary atmospheric, magnetic, and seismic disturbances which occurred in so many parts of the world during the month of February still continue to form the subject of discussion and memoir at the various learned societies. Ch. V. Zenger's recent contribution to this interesting topic, is important inasmuch as he has marshalled all the observed facts connected with these phenomena and has employed them in demonstrating his theory that magnetic storms, cyclones, snow-storms, discharges of atmospheric electricity, earthquakes and volcanic eruptions occur simultaneously and are governed by some common cause.

Submarine Cables of the World.—A leading article recently appeared in the *Morning Post*, which although uninteresting and pointless, at least gives us some new information. It says: "Some interesting statistics have recently been collected relating to the submarine cables of the world. A few of the shorter cables and some of those which do not possess an international character or which are unconnected with the great systems may be reasonably left out of consideration when going into details, but the fact nevertheless remains that if all the submarine cables, long and short, laid throughout the waters of the globe were added together, we should obtain a cable length of nearly 300,000 miles." If we understand this sentence correctly, it means that leaving out unimportant short cables, the total length of the remaining cables of the world still amounts to 300,000 miles. On March 12th we published a note giving the length of submarine cables in the world as about 143,011 nautical miles, which we believe is correct. The statistics to which the *Morning Post* refers must indeed be interesting.

Utilisation of Niagara Falls.—The project put forward by the Oerlikon Company for transferring power from the falls to the City of Buffalo, at a distance of 35 kilometres, contemplates the use of a three-phase alternating current. The power to be transmitted amounts to 5,000 H.P., which will be given off by three or four horizontal turbines. The 4-polar dynamos, with drum armatures, will be directly connected with the shafts of the turbines, which make 250 revolutions per minute. The projected tension amounts to 600—700 volts, which, before entering the leads, will be raised to 25,000 volts. At the other end the current will be transformed to a lower tension, preparatory to its distribution in Buffalo. The Oerlikon Company propose two leads, one for electric lighting and the other for supplying motive power. The guaranteed efficiency of the generators is 96 per cent., and that of the entire line to the second series of transformers 84 per cent.

The Electric Tramway at Halle.—On the conversion of the tramway at Halle, formerly worked by horse-power, to one worked by electricity, under the management of the General Electrical Company (Allgemeine Elektricitäts Gesellschaft), the municipal authorities reserved to themselves a term of two years for testing the electric working. Within this time they had the right of demanding the removal of the electric system and the re-introduction of horse-power. The municipal authorites now consider the trial sufficient, after working for a quarter of a year in summer and winter, and by occasion of a new agreement on account of the extension of the tram lines, they have renounced the above right. We (*Electrotech. Zeitschrift*) receive this intelligence with the more satisfaction, as the tram line at Halle has been installed with a lead above-ground. Thus a proof is given that in Germany, also, there are municipalites which regard the streets, not merely as ornamental places, but as principally subservient to traffic. Of course, arrangements which are practicable at Halle, may not be possible in all the streets of a large city.

Electrical Literature.—A pamphlet recently published by the Boston Public Library shows the growing importance of electrical literature from the standpoint of the public. This 24-page list contains not far from 1,000 titles of works on electricity, not including the telegraph and the telephone, which are to be found in that library. The periodical literature, says the *Electrical World*, has grown to be so voluminous, that there is need of a special index to cover publications of this class in the English, German and French languages. The Boston Library does not attempt to enter into particulars of these, almost the only ones entered in the list being the Philosophical Transactions of the Royal Society of London. Our contemporary points out that in one important particular English electrical books of the present day are much more satisfactory than those of American writers, *i.e.*, "the admirable practice which English authors have of referring the reader to original memoirs" and other sources of information for the student's reference, if he should wish to follow the subject more closely.

Improvements in Obtaining Precious Metals by Electrolysis.—There is a well-known process for extracting gold, &c. from refractory ores which depends upon the combined action of chlorine, a cyanide (*e.g.*, potassium cyanide) and electric currents. This process has recently been improved in certain important particulars. The chlorine is now entirely dispensed with and the electrolyte is kept in a state of circulatory agitation by means of a screw propeller. In one form of apparatus the negative electrode consists of mercury placed immediately under a propeller which is mounted on a vertical shaft passing through the bottom. The positive electrode, in this case, is a hollow inverted cone of carbon mounted immediately over the propeller. By the action of the latter the sludge is drawn through the cone and driven up round the sides to once more enter a hole at the top and continue the circulation. This sludge is composed of the gold or silver ores reduced to a fine powder and mixed with water containing not more than two per cent. of cyanide of potassium.

Shrewsbury Electric Lighting.—The Shropshire Electric Light and Power Company, Limited, have applied to the Board of Trade for powers to produce and supply electricity for public and private purposes at Shrewsbury.

Ripon Town Council and Electric Lighting.—The question of increased storage at the gasworks was considered at the last meeting of the Ripon Town Council, and the opinion was expressed that additional expenditure would be unadvisable in view of probable lighting by electricity. Mr. Laycock, gas engineer, has been asked to advise the council on the subject.

Proposed Electric Lighting at East Molesey.—The General Purposes Committee of the East Molesey Local Board have had before them plans and specifications for lighting the village by electricity. The committee are disposed to view such scheme favourably, provided that the interests of the parish are safeguarded by provisions as to the time in which the work shall be carried out; as to the price for the supply; as to the power of purchasing the concern, and such like matters. The committee intends presenting a detailed report at the next meeting of the Local Board.

Metropolitan Electric Supply Company.—A full report of this company's meeting will be found in our City Notes column. Commenting upon the directors' report, the London *Electrical Engineer* says: "If it is any consolation to the shareholders or to the investing public to have a companies' finance barometer, we would point out that Messrs. Pender, Anderson and Co. are always on hand whilst fine weather is likely to prevail, and being behind the scenes, always manage an excuse for leaving when rough weather looms ahead. These gentlemen are keeping up their connection with the company, so it is pretty certain that, in their estimation, the sailing prospect is fairly satisfactory."

Storage Battery Litigation.—The New York *Electrical World*, in a leaderette, states that friends of the storage battery will find little comfort in the patent litigation in which the manufacturers are still engaged. During the last three years there has been a constant warfare between the several companies, each of which claimed the exclusive right to the manufacture of storage batteries. Our contemporary, further commenting upon the prolonged litigation, says: "In fact it may be said that more money has been expended in the legal controversy than in developing and exploiting the several systems. Despite this fact the companies now engaged in the controversy are in practically the same relative positions that they occupied several years ago. It certainly does not look well to see the electrical companies of Europe installing storage battery plants wherever electric lighting plants are found, while in America the plants of any consequence do not exceed a dozen in number."

"Sulphur is not an Element"!—Dr. Gross of Berlin, is well known, amongst other reasons, for his exhaustive researches on sulphur which have been in progress for many years. He has recently examined the decomposition of this substance electrolytically and his results were communicated at a meeting of the Berlin Physical Society. The sulphates of barium and strontium were fused in a silver crucible which formed one electrode whilst a strong current of electricity was sent through the molten mass by means of a platinum wire electrode standing in it. After the electrolysis had proceeded for a definite time, analytical examinations of the results were made. It was found that the barium had combined with the platinum forming a hitherto unknown compound, and at the same time about fifty per cent. of the sulphur had disappeared, its place being taken by about forty per cent. of another entirely new compound. Dr. Gross considers that these results prove that sulphur is not an element but a compound of this new substance with hydrogen. If this view turn out to be correct and is able to pass unchallenged, we shall be prepared for anything almost in the way of an upsetting of theories in chemistry. Several of our scientists have expressed their suspicion that many of the elements might turn out to be really complex in character. We shall await with interest the reception of this extraordinary result in physical chemistry. If it be substantiated, it will add one more honour to the long list of discoveries attained by means of electrolysis.

Accrington and Electric Lighting.—The scheme for the introduction of electric lighting at Accrington by the Corporation has, for the present, been abandoned, and the Town Clerk's report on the subject has been adjourned *sine die* by the committee until there is a better prospect of the public taking the matter up. The Corporation's order expires in August, but the Board of Trade is not likely to revoke it.

The Physiological Effects of Intermittent Currents.—An interesting experiment of Claude Bernard was referred to by M. D'Arsonval at a recent meeting of the Société Internationale des Electriciens. This experiment consisted in placing a frog's leg, a voltameter, a battery, and an interrupter in circuit. When a continuous current was flowing the frog's leg was not affected, but the voltameter disengaged gas; when, however, the interrupter was actuated, the leg became violently contracted, but the disengagement of gas ceased, thus showing that the muscular effect is not entirely dependent upon the current strength. If the current is very strong, then an effect is produced in the muscles when the current is steady, but it is an electrolytic effect.

Alternating Current Influence Machines.—Mr. T. H. Muras has recently made some experiments with influence machines constructed on the principles of alternating current dynamos. The latest of these machines has forty tinfoil sectors extending over both sides of an ebonite disc 18 inches in diameter, the insulating spaces being comparatively short. This disc rotates between two stationary glass plates carrying corresponding sectors on their outer surfaces. Alternate sectors on the glass plates are connected together, and to the terminals of a small ordinary Wimshurst machine, by which they are kept charged with a difference of potential capable of producing sparks 2·5 mm. long between two small brass balls in air. Alternate sectors on the disc are connected to two collecting rings, one on each side of the disc, these making continuous sliding contact with the stationary brushes. When the disc is rotated, at any speed, strong white sparks 1 mm. long are obtained between the same two balls connected with the brushes, 40 such sparks being produced in each rotation of the disc. A small vacuum tube connected with the brushes is brilliantly lighted, and shows the regular alternating nature of the current when the disc is rotated very slowly. When the machine is allowed to discharge through a spark gap and the primary of an induction coil of few turns, the now familiar Tesla glow discharge is produced on a very small scale from the secondary terminals.

Cost of Gas and Electricity.—The letter which we publish this week from Mr. Yeaman, combined with the recently published statement of Mr. Dibdin, the chemist to the London County Council, show very conclusively that the ELECTRICAL REVIEW has not been holding on to a threadbare theory, unless, indeed, the theory has become threadbare in its very trustworthiness, even when comparing a gas jet of 15 candles against an incandescent lamp of 16 candle-power. A flat flame burner, when in proper condition, and consuming 5 cubic feet of gas per hour, gives 15 candles as a minimum, and this means that 1,000 cubic feet will keep 200 burners supplied per hour, yielding a total light of 3,000 candle-power. A 16 candle-power incandescent lamp requires 64 watts (even the New York *Electrical World*, of April 30th, states definitely that in American practice the wireman had best assume 4 watts per candle-power for safety); therefore the Board of Trade unit will energise 15·6 such lamps for an hour, the light emitted being 249·6 candles. The proportion, light for light, is therefore 1 to 12. Surely these figures are simple enough in all conscience, and, as Mr. Yeaman very pertinently remarks, if there are any doubts about them, why are not others forthcoming to prove their incorrectness. The ELECTRICAL REVIEW has no leaning towards gas, but it has a decided regard for truth. In commenting upon the photometric measurements of the London County Council, as against similar readings of gas companies, our only feeling in the matter was that of the lengthy experience of the one as against the limited time the other has been in existence. The mean results of the two, indeed, go to show that in London 16 candles instead of 15 may generally be looked for in the testing stations, and this more than confirms our contention

Telegraphs in Persia.—The duplex system of working is to be introduced on the Indo-European telegraph line in Persia.

Telephones in Japan.—The construction of several new telephone lines in Tokio have been ordered by the Department of Communications, owing to the large increase in the number of subscribers.

The Electric Light at Lytham, Lancashire.—A new pier and pavilion is approaching completion at Lytham. The whole of the structure is being illuminated by the electric light.

The Electric Light in Paper Mills.—The paper mills of Messrs. Lloyd, Limited, at Sittingbourne, have been installed with the electric light. The generating plant consists of two dynamos driven by a 60 H.P. engine.

The Electric Light in India.—Messrs. Volkart Bros., of Bombay, are fitting up an installation of the electric light in the Esplanade Hotel, Bombay, and are also engaged in fitting up an installation in the Napier Hotel at Poona. The same firm has also been entrusted with the carrying out of an installation at the British Residency at Chaderghat, Hyderabad-Deccan.

The Electric Light in Salford.—At the last meeting of the Salford Town Council, it was resolved to devote a sum of £30,000 for the purposes of electric lighting, the original sum voted of £15,000 being considered insufficient for the proper carrying out of the work. At the same time, it was resolved that the Gas Committee should be instructed to proceed with an installation not to cost more than £30,000.

The Institution of Civil Engineers.—At the ordinary meeting on Tuesday, May 10th, Mr. Berkley, President, in the chair, the paper read was on "The Distribution and Measurement of Illumination," by Mr. Alex. P. Trotter, B.A., Assoc.M.Inst.C.E. This paper was divided into three sections. The first dealt with geometrical principles; the second, with photometers; and the third, with the results of measurements made in the streets and public buildings in London.

The Bolton Corporation and Electric Lighting.—The Sub-Committee of the Town Council having charge of the electric lighting question have finished their enquiries as to the best systems, and will shortly present a report for approval. As soon as that approval is secured the matter will be pushed on with all reasonable speed. Many of the leading tradesmen, particularly the drapers, are anxious that the installation should be made as soon as possible.

Electric Launch Building.—The electrically-propelled launches now being fitted out for the season at the Thames Electric and Steam Launch Company, Eel Pie Island, Twickenham, and Strand-on-the-Green, Chiswick, are as follows:—The *Glow-worm*, for Andrew Pears, Esq., also the *Pilot*, an electric pinnace, for the same gentleman; the *Meteor*, late *Pioneer*, for Arthur Ash, Esq.; and the *Florentia*, for W. T. Crawshay, Esq., of Caversham Park, Reading.

Electric Lighting in Nottingham.—The Electric Lighting Committee of the Nottingham Town Council have had under their consideration applications for the post of electrical engineer in Nottingham. The salary offered was £300 per annum. There were 147 applicants. The committee have decided to offer the post to Mr. H. Talbot, at present engaged as engineer to the Chelsea Electricity Supply Company.

The Electric Light on Southampton Pier.—The new electric lighting apparatus at the new pier at Southampton was subjected to a very satisfactory trial last week by the contractors, Messrs. Shalders & Co. The current was switched on about 9 o'clock, and the general effect was very satisfactory. The whole of the lighting arrangements are not yet complete, but judging from the satisfactory nature of last week's trials, there can hardly be any doubt that the illumination of the place will be all that can be desired.

Electrical Exhibition.—At the annual exhibition of the Royal Cornwall Polytechnic Society, to be opened on August 23rd, there will be special exhibits of electrical appliances.

Antidote for Mercurial Poisoning.—We would draw our readers attention to the article on the above subject, appearing elsewhere in our columns this week. As pointed out, the practice is a most meritorious one.

Society of Arts.—At the twentieth ordinary meeting on Wednesday evening, May 11th, a paper on "The Uses and Applications of Aluminium" was read by G. L. Addenbrooke.

Bermondsey Vestry and the Electric Light.—At last week's meeting of the Bermondsey Vestry, the surveyor reported that he had received estimates for laying down the necessary plant and fittings for supplying the electric light to the Town Hall. Messrs. Joel & Co. undertook to do the work for £1,068; Messrs. Siemens, £1,560. No action was taken in the matter.

Electric Motors and Haulage.—The members of the Midland Institute of Mining, Civil, and Mechanical Engineers, and members of the Chesterfield and Midland Counties Institute of Engineers held a joint meeting at the Royal Victoria Hotel, Sheffield, on Tuesday. A paper was read by Mr. W. G. Phillips on "Colliery Haulage." In the discussion which followed, allusion was made to electric machinery in pits.

Attempt to Blow Up a Tramcar.—A telegram through Reuter's Agency, in last night's *Standard*, dated Budapesth, May 12th, says:—"Last night, as one of the cars on the electric tramway was passing through Andrassy Street, a loud explosion was heard, and the car was shaken from end to end, without, however, being overturned. No one was hurt. It was found that one of the wheels had been blown to pieces by the explosion of a dynamite cartridge, which had been laid along the line. By its side were seven other cartridges enclosed in tin, but these had not exploded; apparently the fuses had gone out. During the late hours of the evening the tramcars are crowded with people, and had the eight cartridges exploded together a shocking loss of life would have followed inevitably. There is no clue to the perpetrator of this outrage."

Obituary.—We much regret having to announce the death of Dr. James Thomson, lately Professor of Civil Engineering and Mechanics in the University of Glasgow, which took place on Sunday morning at his residence, 2, Florentine Gardens. Professor Thomson was born in Belfast in 1822. Early in life James Thomson and his brother, William Thomson (Lord Kelvin), showed that high inventive genius which has distinguished them through life, and James Thomson chose for his career that of a civil engineer, serving his apprenticeship (after he had taken the degree of M.A.) in the works of the late Sir William Fairbairn. Mr. Thomson, after the term of his apprenticeship was concluded, commenced business in Belfast as a civil and mechanical and hydraulic engineer. In 1857 he became Professor of Civil Engineering in Queen's College, Belfast, an office which he held till the death of the late Professor Macquorne Rankine in 1872. He was then elected to fill the Glasgow chair, and he continued to fill the duties of that office till 1885, when he was obliged, owing to failure of his eyesight, to seek retirement. In spite of the sad blow which had thus fallen upon him Prof. Thomson maintained all his zeal for scientific pursuits and investigations; and, in March of this year, he completed a substantial paper on "The Grand Currents of Atmospheric Circulation," which was crowned by the Royal Society as the Bakerian Lecture for the year. Prof. Thomson was the author of very numerous original papers on various subjects connected with physics. In 1847 he communicated to the Royal Society of Edinburgh a most important paper on the "Lowering by Pressure of the Freezing Point of Water." He led the way to the development of thermo-dynamics, which in the hands of Clausius, Rankine, and others, have done so much for the great modern improvements in the steam engine.

Sevenoaks Electric Lighting Order.—It has been decided by the Sevenoaks Local Board to request the Board of Trade to revoke the electric light order as desired by the promoters of the scheme.

Recording Measuring Instruments.—The curves to which Sir Thomas S. Bazley refers in his letter, p. 620, are very interesting, and clearly defined, but we did not think it necessary to reproduce any portion of them. As he says, the tracings of the pen form a faithful record of the condition and behaviour of the secondary battery.

The Crystal Palace Electrical Exhibition.—We understand that a meeting of the exhibitors has been called for 4 o'clock to-morrow, to enable a decision to be taken as to the closing, or otherwise, of the Exhibition at the end of May. As it will have been open fully four months by the 31st inst., and as the evenings are now so light, thus marring the effect of the electric display, we have no hesitation in saying that the notice should at once be given to the public that it will be closed on that date. We have consulted several of the exhibitors, and they are unanimous in holding the same opinion.

South American Cable Company.—We are informed that the ss. *Silvertown*, belonging to the India-Rubber, Gutta-Percha and Telegraph Works Company, arrived and sailed from Teneriffe on the 8th inst. and to-day is due in Senegal, where she will commence the operations connected with the laying of the new cables for the South American Cable Company. These cables comprise one section from St. Louis in Senegal to the Brazilian Island of Fernando Noronha, and a second section from this Island to Pernambuco in the United States of Brazil. The total length of cable is 2,158 nautical miles, weighing 4,946 tons, and the total weight on board the cable steamer, including coals and stores, amounts to 6,500 tons. A considerable amount of sounding work will be carried out with the view to the selection of the best possible bed for the cable to lie on. It is expected that the line will be completed by the middle of July.

Telephone Rates.—A large and influential meeting of subscribers to the National Telephone Company in Sheffield and the district was held on the 9th inst. at the Cutler's Hall, to protest against the recent revised tariff of rates, and "to consider what united action should be taken in connection therewith." The revised tariff referred to is a minimum subscription of £7 per annum, entitling the subscriber to 1,000 conversations, and the payment of one penny for each subsequent conversation. The feeling of the subscribers in regard to this system of payment may be judged by the expression of one speaker, who said that unless the company withdrew their obnoxious circular, they would be told to withdraw their poles and wires. Mr. Gaine, the general manager of the National Telephone Company, addressed the meeting in a conciliatory speech, and a representative committee of subscribers was appointed to confer with the company with a view to arranging satisfactory terms, failing which a rival service by the subscribers themselves or by the new company—who had offered to start an exchange at a rate of £8 per annum—was threatened.

The Lisbon-Azores Cable.—A *Times* correspondent telegraphs from Lisbon on 10th inst. as follows:—"To-day's *Diario* contains an announcement inviting tenders, to be handed in by the 25th inst., for the construction and working of cables from Lisbon to all the principal Azores islands. Provision must also be made for the continuation of the cable to Flores Island and North or Central America, and also for constructing a cable from Lisbon to a point on the Continent of Europe. A provisional deposit of £10,000 must be made for the privilege of competing, besides one of £20,000 in the event of the tender being accepted. The scheme of construction is based principally on the clauses of the contract entered into last February between the Portuguese Government and the British company, but it has apparently been modified so as considerably to facilitate a tender from the French syndicate, and I understand that in any case it does not admit of such advantageous terms for Portugal as those lately offered by the British company. The matter appears to have an international importance."

The Royal Society.—Prof. Perry, F.R.S., was down for reading a paper on "Transformers" before this society last night.

An English Invasion.—A meeting of the Association of Belgian Mining Engineers was held in Liege on the 7th, at the new Montefiore Electrical Institute. The President introduced to the meeting Mr. Llewelyn B. Atkinson of London, and Mr. D. Selby Bigge of Newcastle-on-Tyne. After an interesting description by Prof. Eric Gerard of the Institute and its work, Mr. Selby Bigge read a paper on "L'Application d'Electricite dans les Travaux des Mines," illustrated by an exhibition of photographs, diagrams and models. In the course of his lecture the author referred to the important question of safety in mines, and described the various precautions taken by Messrs. W. T. Goolden & Co. in the manufacture of their electric mining machinery, and by himself in the laying down of the same. After the paper a hearty vote of thanks was passed to the author for his most interesting paper, and also to Mr. Llewelyn Atkinson for his attendance. The whole company present then visited the laboratories and workshops of the Institute, and were much interested and pleased by the complete arrangements for training electrical engineers as well as for the research work. It is interesting to note that the whole of the internal wiring of the Institute is carried out by wires twisted together to avoid the influence of the current upon the delicate instruments used.

Taunton Lighting.—We have much pleasure in inserting the following letter from Mr. Gisbert Kapp:—"In one of your notes last week, you report that at a meeting of the Taunton Town Council it was decided to make enquiries 'as to the successful working of the Thomson-Houston system in other places, and whether Mr. Kapp was interested in any other system of electric lighting.' The concluding part of this sentence is calculated to give your readers the impression that I have a personal or monetary interest in some system of lighting, and that this was the reason why I would not advise the purchase of the existing installation as a going concern. As such an impression is likely to damage my professional standing as an independent consulting engineer, I must ask you to afford me space for stating the following facts:—1. I am neither directly or indirectly interested, in a monetary sense, in any particular engine, dynamo, alternator, transformer, main, &c., nor have I any pet scheme for town lighting. 2. I own no English patents. I have sold all my English patents, with attached licenses, outright, the purchasers being Messrs. Allen & Co., the Westinghouse Company, and Messrs. Johnson and Phillips. 3. The Mayor and Town Clerk of Taunton called on me last week to discuss certain points in my report, and in answer to a direct question from me, the Town Clerk declared himself as satisfied that my report was not biassed."

NEW COMPANIES REGISTERED.

Mather and Platt, Limited.—Capital £200,000, in £10 shares. Objects: To acquire and take over as a going concern the business of steel and iron founders, mechanical and electrical engineers and millwrights, now carried on by Messrs. William Mather and John Platt, at the Salford Iron Works, Salford, Lancashire, under the style of Mather and Platt; to enter into and carry into effect an agreement about to be made between Messrs. W. Mather and J. Platt and the company, and to carry on the business in all its respective branches. Signatories (with 1 share each), William Mather, John Platt, Edward Hopkinson, Colin Mather, Thomas Thorp, John Milligan and Andrew W. Manson, all of Salford Iron Works, Manchester. William Mather is to be governing director and chairman of the board so long as he continues to hold 1,000 shares. John Platt is to be managing director and deputy chairman, so long as he holds 1,000 shares. Edward Hopkinson and T. Thorp are also to be managing directors, and each shall hold office so long as he continues to hold 250 shares. Remuneration, £4,000 per annum, to be divided among the managing directors.

Abell's Electrical Engineering Company, Limited.—Capital, £5,000 in £5 shares. Objects: To acquire the goodwill of the business of electrical engineers carried on by T. K. Abell and W. Hughes, at the steam factory, Raglan Street, St. Helen's, and to carry on the business of an electric light supply company, and also that of electricians, electrical and mechanical engineers, &c. Signatories: T. K. Abell, The Stoops, St. Helen's (65 shares); W. Hughes, 22, New Cross Street, St. Helen's (55); P. B. Glover, Lime Grove, St. Helen's (50); J. W. Glover, St. Ann's, St. Helen's (30); S. Urmson, Cowley Hill Lane, St. Helen's (20); W. J. Glover, The Ropery, Liverpool Road, St. Helen's (20); J. Hodson, The Ropery, Liverpool Road, St. Helen's (10). Registered, without articles of association, on the 3rd inst. by Barlow and James, 49, Lime Street, E.C.

Sheffield Electric Light and Power Company, Limited.—Capital £98,000 in £7 shares. Objects: To acquire and take over as a going concern the electric lighting and electrical fitting business of the Sheffield Telephone Exchange and Electric Light Company, Limited; to enter into an agreement with the old company, referred to in clause 2 of the articles, and to carry on the business of electricians, mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus. Signatories: John Tasker, Joseph Gamble, George Senior, George Franklin, William Tasker, Frederick Tasker and John H. R. Tasker, all of Sheffield, each of whom take one share. The number of directors is not to be less than three nor more than seven, the first being the first five signatories. Qualification £150. Remuneration to be determined by the company in general meeting. Registered on the 3rd inst. by Charles Doubble, 14, Sergeant's Inn, Temple, E.C.

T. Potter and Sons, Limited.—Capital, £20,000 in £1 shares. Objects: To acquire and carry on the business of engineers, iron, and brass founders, art metal workers, electric light, sanitary and general engineers, safe and lock makers, &c., carried on under the style of T. Potter and Sons, at 43, 44 and 45, South Molton Street, at 361, Oxford Street, at West End, Hampstead, and elsewhere. Signatories (with 1 share each): T. Potter, The Wilderness, Pinner; G. E. Sadler, 22, Great Tower Street, E.C.; H. A. Potter, 105, Fordwych Road, West Hampstead; E. Parr, Brazil House, Isleworth; L. A. Withall, Suffolk House, E.C.; J. R. Pakenham, 76, King William Street, E.C.; C. Maitland, 2, Pinners Court, E.C. The number of directors is not to be less than three nor more than seven; the first being L. A. Withall, G. L. Sadler, T. Potter, jun., H. A. Potter, and E. Parr. Qualification, £100; remuneration, £50 each per annum, with a percentage of the profits. H. A. Potter is the managing director, with a salary of £200 per annum. Registered on the 26th ult. by J. R. Pakenham, 76, King William Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Tramways and General Syndicate, Limited.—The annual return of the above company, made up to December 31st, 1890, was filed on the 3rd inst. The nominal capital of the company is £10,000, divided into 1,850 "A" shares and 150 founders' shares of £5 each. Seven "A" and 87 founders' shares had been taken up, and upon the founders' shares the full amounts have been called and paid, while upon the "A" shares no calls have as yet been made.

The return for 1891, made up to December 31st, 1891, and the return for 1892, made up to April 22nd, were both filed on the 3rd inst., and are in all respects similar to the foregoing. Registered office, 81, Gracechurch Street, E.C.

"Electrical Plant," Limited.—An agreement made March 14th (and filed on the 21st) between H. S. Price and Wallis R. Goulty (the vendors) of the one part and the company of the other part, determined that in consideration for the goodwill and interests of the vendors in the monthly journal known as *Electrical Plant*, 500 fully paid £10 shares should be allotted to them or their nominees, and the following is the manner in which the allotment took place:—H. S. Price, 246 shares, numbered 1 to 246 inclusive; W. R. Goulty, 246 shares, numbered 247 to 492 inclusive; E. R. Dolby, 5 shares, numbered 493 to 497 inclusive; S. Sherley-Price, 1 share, numbered 498; W. H. Goulty, 1 share, numbered 499, and M. Bélsham, 1 share, numbered 500. Registered office, 52, Queen Victoria Street, E.C.

Electric Lighting and General Development Syndicate, Limited.—An agreement made March 30th (filed 4th ult.), with H. B. Taylor, solicitor, determined that for professional services rendered, and to be rendered, 12 ordinary shares of £10 each, numbered 8 to 19, inclusive, should be allotted to him as fully paid.

An agreement made the 2nd inst. (filed on the same day) with W. J. Whelen, determined that in consideration for services rendered, and to be rendered, as secretary to the company, 8 ordinary fully paid shares of £10 each, numbered 31 to 38, inclusive, should be allotted to him in lieu of salary. Registered offices, 31, Crutched Friars, E.C.

LEGAL.

In Re the Islington and General Electric Supply Company (Limited).—In this case, which came before Mr. Justice Chitty in the High Court of Justice, Chancery Division, on the 4th inst., made an order, upon the petition of the company, confirming a resolution for reduction of its capital.

Mr. Justice Chitty now said that, upon consideration of the order of March 26th, 1892, and the Acts of Parliament bearing on the question, the view he took was that the order did not affect the previous jurisdiction except in a particular portion—namely, the winding up of companies. The jurisdiction of the Chancery Judges in other company business—*e.g.*, petitions for the reduction of capital and petitions under the Companies (Memorandum of Association) Act, 1890—remained as before the order was made. His Lordship added that Mr. Justice North, Mr. Justice Stirling, and Mr. Justice Kekewich concurred in this view. The order made on the present petition, therefore, should not contain any recital to the effect that the petition was heard or the order made at the request of Mr. Justice Vaughan Williams.

Mr. Byrne, Q.C., and Mr. Charles Macnaghten appeared for the petitioners.

Edison-Swan United Electric Light Company, Limited v. Brehmer.—Auguste Frederick Brehmer was indicted before the Common Sergeant at the Central Criminal Court for stealing 27 oz. of platinum wire, value £30, the goods of the Edison-Swan United Electric Light Company, Limited. Brehmer, however, when charged with the theft, said that the metal found in his possession was brought by him from New Zealand, he having travelled in various parts of the world, and worked in the gold mines. Witnesses were called for the defence, and the Jury acquitted the prisoner.

BUSINESS NOTICES, &c.

Telephone Tenders.—The following is a list of the tenders received for fitting up telephones, &c., at the Metropole Hotel, Dublin, April 27th. The difference between the highest and the lowest is more than 3½ to 1.

	£	s.	d.
Manchester and Liverpool Electric Company, Liverpool	855	0	0
Smeaton & Page, London	625	0	0
G. A. Nussbaum, London	600	0	0
R. S. Blackburn, Hebden Bridge	570	0	0
William Johnson & Co., Sheffield	528	0	0
W. A. Shaw & Co., Stockport	495	0	0
J. B. Saunders, Cardiff	460	0	0
Birmingham Telegraph Factory, Birmingham	449	0	0
Harold Clegg & Co., Manchester	430	0	0
Croggon & Co., London	420	0	0
The Goodwin Electrical Company, Dublin	419	5	0
W. Curtis & Sons, Dublin	400	0	0
Thomas Barton, Blackburn	373	0	0
Maunsell, Mercier & Co., Manchester	345	0	0
J. Blackburn, Nottingham	315	0	0
E. L. Berry, Harrison & Co., London	300	0	0
Matthews, Ball & Co., Leicester	298	10	0
Electrical Engineering Company of Ireland, Dublin	290	0	0
McClellan & Co., London	291	10	0
D. & G. Graham, Glasgow	290	0	0
E. J. Dugdill & Co., Manchester	290	0	0
Gent & Co., Leicester	285	0	0
C. C. McCarthy, Belfast	265	0	0
Hills & Thomson, Limited, Liverpool	258	0	0
John Pearce, Glasgow	249	10	0
James Fletcher & Co., Burnley	235	15	0

The Electrical Engineering Company of Ireland's tender was accepted, and the contract has been given to them for the sum stated, £290.

Ernest Scott and Mountain.—We understand that Benmore House, the residence of Henry J. Younger, Esq., is to be lighted by electricity, and that the contract for the carrying out of the work has been placed with Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, Close Works, Newcastle-on-Tyne. The installation, we are informed, will consist of a Priestman oil engine, capable of working up to 18 brake horse-power, driving on to a Tyne shunt-wound dynamo of 12,000 watts capacity. Accumulators will be supplied for storage, and will be placed in the accumulator house next to the dynamo room, the battery of accumulators being capable of maintaining 80 lamps for 10 hours when fully charged. The total number of lamps that will be installed throughout the house will be about 180 to 200. Mr. W. A. Bryson, of Glasgow, has been appointed superintending engineer on behalf of Mr. Younger, and Messrs. Mountain & Co., of 7, Bothwell Street, Glasgow, representatives for Messrs. Ernest Scott and Mountain, Limited, in Scotland, will superintend the carrying out of the work. Through their Scotch agents, we are informed that this firm have already supplied numerous electric light installations, including the firms of Messrs. Paterson, Elder & Co. and Messrs. Cran & Co., both of Leith, Messrs. Hutchinson & Co., of Kirkcaldy, and have recently completed contracts for the lighting of the Glasgow Iron and Steel Company's works at Wishaw, and one of their collieries at Motherwell.

The Electric Light in the City.—Since our last report of the electric light in the City, we find that an installation is being fitted in the premises of Messrs. Willcox and Gibbs, of sewing machine fame, 37, Moorgate Street, E.C., by Messrs. Sharp and Kent, Victoria Street, S.W.—The premises of Messrs. Norton & Son, tailors, 21, Moorgate Street, E.C., are being fitted by Messrs. Ewart and Son, of Euston Road, N.W.—Messrs. Sharp and Kent are fitting up an installation at No. 9, Old Broad Street, E.C.—The premises of Messrs. Tomlinson and Gale, outfitters, 47, Cornhill, E.C., are being fitted by Messrs. Benham and Sons, of Wigmore Street, W.—Messrs. Laing, Wharton and Down, of New Bond Street, W., are carrying out two installations in Abchurch Yard, Abchurch Lane, E.C., one in the offices of the Broken Hill Proprietary Company, and one in the premises of Mr. Francis Howse, solicitor.—Messrs. Vaughan and Brown, of Kirby Street, E.C., are fitting up an installation in the Cannon Tavern, Cannon Street, E.C., and Mr. Robert G. Ivey, of Portpool Lane, E.C., is fitting up an installation in Devonshire House, 13, Bishopsgate Street Without.

Catalogue.—A catalogue has just been prepared by Messrs. G. E. Belliss & Co., of Birmingham, of their manufactures. It is well printed, and very fully illustrated. Amongst other things we notice particulars of their direct-acting electric light engines, pumping engines, launch and torpedo boat machinery, air-compressing machinery, &c. This is the first time Messrs. Belliss have published any particulars in catalogue form, and we think it will prove most useful to the firm's customers. For most of the machinery, of which information appears, they prefer to give special quotations; it is therefore an illustrated list, not a price list.

The Electric Lighting of Ships.—A complete installation of the electric light on the double-wire system is being fitted by the Woodside Electric Company, of Glasgow, throughout the new steel screw, *Catherine Apcar*, recently launched by Messrs. D. and W. Henderson, Partick, N.B. Messrs. J. H. Holmes and Co., of Newcastle, are fitting an installation throughout the new steamer *Skerryvore*, recently launched by Messrs. Richardson, Duck & Co., of Stockton.

Tenders Wanted.—Telegraph Stores. — The Great Eastern Railway Company are inviting tenders for the supply of telegraph materials, as well as various other stores. Tenders, endorsed "Tenders for Stores," to be forwarded by post to Mr. T. D. Gentloud, Secretary, Liverpool Street Terminus, London, E.C., so as to be received by 10 a.m. on 21st inst.

Tenders Wanted.—Telegraph Arms.—Persons who are in a position to supply the Postmaster-General with telegraph arms of good South of England oak, planed, bored, and chamfered, are invited to apply to Mr. C. E. Stuart, controller of stores, Telegraph Street, London, E.C., for specification and other particulars.

Tenders Wanted—Glasgow.—The Committee of the Glasgow Town Council on gas supply and electric lighting are inviting tenders for the providing and erection of a switchboard with connections, &c., at their central electric lighting stations. Full particulars will be found in our advertisements.

Tenders Wanted.—Oldham.—Tenders are invited by the Corporation of Oldham for boilers, engines, dynamos, &c., for central electric lighting station. Full particulars will be found among our advertisements.

The Crompton-Howell Electrical Storage Company, Limited.—This company has just received an order from the Glasgow Corporation for 120 61-plate cells of 1,000 ampère-hour capacity. Extensive repeat orders have also been received from Montreal and Australia.

The Electric Light in Glasgow.—The new buildings for the Glasgow Athenæum, in Buchanan Street, are to be fitted with the electric light, and Messrs. J. H. Holmes, of Newcastle, have been entrusted with the contract.

The Electric Light in Chelsea.—The premises of Mr. Grant, Butcher, of 30, King's Road, Chelsea, are being fitted with the electric light by Messrs. Barnes and Low, Exhibition Road, S.W.

Crompton and Company, Limited.—Contracts have recently been booked by this company to the extent of £17,000 for underground mains on the Crompton patent system.

Sale.—We would remind our readers of the sale of engines, boilers and machinery which takes place next Tuesday and Wednesday at 39, Queen Street, E.C.

CITY NOTES.

Western and Brazilian Telegraph Company, Limited.

THE twenty-third ordinary general meeting of this company was held yesterday at Winchester House, Mr. W. S. Andrews presiding.

The SECRETARY (Mr. Cunningham) read the notice convening the meeting, also the minutes of the last meeting.

The CHAIRMAN, before proceeding with the ordinary business of the meeting, stated that since the report had been issued the directors had accepted Mr. Coppen's offer to take office on the board as a director, seeing that there seemed to be unanimity amongst the shareholders that it should be so. Referring to the company's working, they would have seen on the perusal of the report that, to a certain extent, it was anomalous. There was a fair increase in the traffic, but although the volume of the traffic was growing, the money that the traffic produced had been diminished. Taking December, 1890, their receipts amounted to £108,817, the last half-year they amounted to £92,345, that was a decrease of £16,472, but the whole thing was explained beyond question when they said that for the half-year ending December, 1890, the loss on exchange was £731, and for the half-year ending December, 1891, their loss on exchange was £19,133. In other words, if the exchange had been this year as favourable as it was the previous year, they would not only have had an increase of the work done, but an increase in the money earned, and their position would have been practically the same as it was last year, and they would have had the same dividend. The difference of dividend was owing exclusively to the loss on exchange, which was, of course, a matter beyond their control. The effect of that did not end there; when they had about 17 per cent. more work, it cost something to do it. They had had anything but favourable conditions, and therefore it was very satisfactory to see that the total increase was only £1,204, in spite of the increased work. He then made some remarks regarding Abstracts A, B, and C in the accounts. When they had done 16·80 per cent. more work under unfavourable conditions and constant difficulties with regard to the staff, and all contingencies had to be met, that with all these difficulties and all the increase of business, they had unfortunately got £19,000 less money for doing it. For some months, as arranged at the last meeting, they had discontinued the weekly publication of their traffic returns. They had now gone down considerably, and the reasons which actuated the directors in stopping the publication having been removed, the publication was resumed. Their competitions, he said, had been referred to at almost every meeting that had been held. He had again to speak of them as before, that the competition so far had not done them any apparent injury. The French line did not appear to be doing them any great harm. The Central American Company was stopped during a great part of 1891 on account of the war in Chili. It was re-established last September, and they had got to work again. On May 1st they reduced the rates. The speaker's impression was that that was done because they were not getting enough of the traffic. The Western and Brazilian Company followed that reduction. They could not tell what the effect of that would be upon the traffic. Attention was drawn at the last meeting to another line which was threatened; the cable had since sailed and would probably be very speedily laid between Pernambuco and Senegambia. At Senegambia it joined up with the Spanish International line which continues from Senegambia along the African coast, and lands finally upon the continent of Europe. It was quite impossible for him to forecast what the result of the opening of that line would be. It must always be remembered that those cables were single cables, whilst their own was a duplicated system. They had not been idle; they had prepared for those things. Since they last met they had had a very satisfactory agreement with the Brazilian Submarine Company; they had arrived at the conclusion that the prudent thing was to duplicate the only bit of cable remaining unduplicated over a busy section, at once. The outlay was very considerable but an agreement was made and the Brazilian Submarine Company upon the laying of that cable would begin to pay them at the rate of a fixed £6,000 per annum for all time. That would be from Santos to Chuy, but they would observe that the completion of it gave them a complete duplicated system of the way from this country and Europe to Brazil. The object of the new cable company was to put prohibitive rates against the Western and Brazilian, so that they should not get any Chilian traffic. The companies interested—the West Coast of America Telegraph Company, Brazilian Submarine Company, and themselves, met and made arrangements under which the lines existing at present at Buenos Ayres should be extended over to the Chilian coast by land line. That work was actively proceeding. They believed that would have a very good effect and enable them to compete for the Chilian traffic very favourably. The companies interested had armed themselves at every point, and hoped to be able give a good account of themselves. The reserve had been rapidly diminishing under all these circumstances. After some further remarks the chairman proposed the adoption of the report and accounts, and the declaration of the dividend.

Mr. C. W. EARLE seconded the motion.

Some questions by the shareholders regarding the accounts, the

ships, and the reserve having been satisfactorily answered, the motion was put to the meeting and carried unanimously.

Mr. Coppen was next elected a director of the company, and the retiring directors (Messrs. C. W. Earle and Mr. D. H. Goodsall) also the auditors having been re-elected, the proceedings terminated.

West India and Panama Telegraph Company, Limited.

THE directors' report for the half-year ended December 31st, 1891, to be submitted to the thirtieth ordinary general meeting, May 17th, 1892, states that the amount to credit of revenue is £36,141 2s. 8d., against £43,978 19s. 8d. for the corresponding half-year of 1890, and the expenses have been £25,296 3s. 11d. against £21,898 3s. 11d. for the same period in 1890, leaving a balance of £10,844 18s. 9d., which, with £5,255 10s. 2d. brought from last account, makes a total of £16,100 8s. 11d., with which it is proposed to deal as follows:—

	£	s.	d.
First preference shares—			
Dividend, 6 months to December 31st, 6s. per share	10,368	18	0
Second preference shares—			
Dividend, 6 months to December 31st, 6s. per share	1,400	14	0
Ordinary shares—			
6d. per share (free of income tax)... ...	2,208	0	6
Balance to current half-year's account ...	2,122	16	5
	£16,100	8	11

The traffic receipts for the six months show a decrease of £7,350 15s. 8d., as compared with the corresponding period, due to the reduction of tariff, and to the condition of West India trade mentioned in the last report. As anticipated in that report, there has been an increase in the cost of repairs to cables, which amounts this half-year to £15,056 (as compared with £9,155 for the corresponding period). Of this sum £2,119 has been taken from the reserve fund. The laying of the new cable between Trinidad and Demerara was completed by the company's ss. *Grappler* on November 18th last, thus affording duplicate telegraphic communication to the latter colony. All the colonies served by this company are now connected by double lines of cables. In exercise of the authority conferred upon the board by resolutions passed at the ordinary general meeting of the company, held on May 13th, 1891, debentures to the amount of £80,000 (part of the £100,000 thereby authorised) have been issued at par, bearing 5 per cent. interest, as from January 1st last. This issue has been applied to the payment of the £50,000 debentures which fell due on December 31st, 1891, and for the part payment of the St. Vincent-Barbados and Trinidad-Demerara duplicate cables. In accordance with the articles of association, Henry Holmes, Esq., and Henry Weaver, Esq., retire at this meeting, and offer themselves for re-election. John George Griffiths, Esq., the auditor, also retires, and offers himself for re-election.

Chelsea Electricity Supply Company, Limited.

THE directors' report for the year ended December 31st, 1891, states that the number of lamps installed on December 31st, 1890, was 19,580, and on December 31st, 1891, 27,500; the number installed at the present time is over 30,000. The gross revenue for the year is £10,172 10s. 11d., as against £6,079 12s. 5d. for 1890; and the gross profit for the past year £1,750 11s. 4d., as against £542 19s. 5d. for 1890. There has also been a decided reduction in the cost of producing the electricity, but, as the new chimney and the re-arrangement of the plant were not completed until the end of the year, the improvement was obtained only in the last quarter of the year, as the following figures will show. The coal, water, wages, and other running expenses, for the first nine months of the year amounted to 4·5 pence per unit sold, while for the last three months of the year they were only 3·0 pence per unit, or 37½ per cent. of the revenue, and there is every reason to believe that the improvement will continue. The management expenses, including rent, rates, and taxes, now represent 1·9 pence per unit sold, as against 3·0 pence per unit for 1890. The plant is all in good working order, and the mains are in first rate condition and have given no trouble. It has not been deemed advisable to make an issue of the preference capital authorised by the shareholders at their last meeting, but the remaining £10,000 first mortgage debentures (part of an issue of £30,000) have been allotted. The money thus raised has been applied to the purchase of a site for an additional storage station, to additions and improvements to generating plant, to enlargements and extensions of mains, and to the building of a second chimney stack. The directors have to report the retirement from the post of managing director of Major-General Webber, C.B., who retains his seat on the board as deputy-chairman. The retiring directors are Major-General Webber, C.B., and Mr. Daniell, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also offer themselves for re-election.

ABSTRACT OF ACCOUNTS TO DECEMBER 31ST, 1891.

CAPITAL ACCOUNT.

DR.	£	s.	d.
To Expenditure per last account	58,762	16	4
„ Further expenditure to December 31st, 1891 ...	15,958	0	8
	£74,720	17	0

CR.	£	s.	d.
By Ordinary shares of £5 each...	46,385	0	0
„ Founders' „ £1 each...	500	0	0
„ Debentures	25,500	0	0
	£72,385	0	0

REVENUE ACCOUNT.

DR.	£	s.	d.
To Generation of electricity	5,260	0	5
„ Distribution of electricity	810	14	6
„ Proportion of rents, rates, and taxes	452	4	6
„ Proportion of management expenses	1,802	0	6
„ Proportion of law and parliamentary charges ...	35	6	8
„ Special charges	61	13	0
„ Balance being gross profit	1,750	11	4
	£10,172	10	11

CR.	£	s.	d.
By Sale of current per meter „ „ „ under contract	9,681	19	1
„ Rental of meters, converters, &c.	299	11	8
„ Transfer fee	0	2	6
„ Other items	190	17	8
	£10,172	10	11

NET REVENUE ACCOUNT.

DR.	£	s.	d.
To Interest on debentures	1,205	19	3
„ Fees to trustees	100	0	0
„ Balance of suspense account	297	9	0
„ Bad debts and interest on mortgage	82	6	8
„ Balance	132	0	0
	£1,817	14	11

GENERAL BALANCE SHEET.

DR.	£	s.	d.
To Capital account	72,385	0	0
„ Sundry creditors on open accounts...	5,433	16	11
„ Net revenue account, balance at credit thereof ...	132	0	0
„ Bills payable	3,094	12	4
	£81,045	9	3

CR.	£	s.	d.
By Capital account	74,720	17	0
„ Cash at bankers „ „ in hand	1,519	17	8
„ Sundry debtors for current	4,062	2	6
„ Stores on hand	742	12	1
	£81,045	9	3

The Metropolitan Electric Supply Company, Limited.

THE fifth ordinary general meeting of this company was held on Friday last at Winchester House, Sir John Pender in the chair.

The Secretary having read the notice convening the meeting, the report was taken as read.

The CHAIRMAN stated the resolution that he had to put was that the report and accounts for the year ending December 31st, 1891, presented to the meeting, be approved and adopted. Before, however, asking them to approve of the resolution, he gave them a *resumé* of the last year's work. When he had the pleasure of addressing them twelve months ago, he was able to report that their installations were all but completed, that their mains extended for 67 miles, and that they had 400 customers upon their books, and looking at the rate at which they had calculated as being the proper rate that they might possibly earn, they saw the prospect of a very good profit. Their position to-day was in many respects strengthened, because they had had upwards of 1,000 customers upon their books, as against less than 500. Yet those customers were learning how to economise, and their consumption had not been in proportion to the increased turn-out, but they had the satisfaction of learning from experience, and after all their knowledge of electric lighting was best upon experience, that they were gathering from day to day; but taking the consumption from their meters, the probability was that they would be able to supply double, or even more than double the number of lights they originally contemplated, so that all the expenses in connection with the production of the light had been, he might say, already incurred, and what they wanted now was more customers rather than a larger rate of consumption from the present number. At all events they were not depending upon that, but upon additional customers, because he would rather see their return based upon 5,000 customers, than upon 2,000; so that what they wanted now was to exercise patience and push the business. It was a paying concern; it was growing every day, and they were passing through very much the same phase of trouble as the gas companies and the telegraph companies passed through—which latter companies had been passing under his own eye. He could say that there was a very satisfactory

future before them; a satisfactory future to those who stood by the company. There would also be a growing dividend. They did not contemplate Paddington in their first outlay, and therefore they exceeded their capital expenditure by about £50,000, but in that case they had brought a very important district into their system, one which was likely to prove valuable in the future. Concerns like this must grow, and when they had secured for it an amount of customers to take up all the lights that they could produce, it would then turn out a very important installation for the company. He thought it would be right to give them at the moment an idea of the position of their company, as compared with the other companies. On January 1st, 1892, the London Electric Supply Corporation had 36,000 lights; Westminster Corporation, 62,000 lights; Kensington and Knightsbridge, 38,000; St. James's and Pall Mall Company, 38,000; Chelsea Company, 28,000; House-to-House Company, 19,000; Notting Hill, 3,000; their own company, 82,000, and they had since increased to 97,000, and that morning (Friday) he found that in the last three weeks they had obtained an application for 5,137 lamps. That was the largest number ever obtained in the same time; so that they would see they had got everything ready to supply the public. They had the public almost clamouring to get on to their list, and it was therefore a question with them of patience, and if they stood by the growing concern, they might depend upon it the same harvest would be reaped in the future that was now being reaped by the gas and telegraph companies, but it required patience. There had been, he thought, unfortunately for electric lighting, a great deal of speculation. They had not been in that speculation. They built up the concern not upon a speculative system at all; they built it up with every installation established independent of the other, and to work singly or together. They had, he believed, the most complete, the most economical, the most handy system of electrical lighting that existed in the City of London at the present time. Their own speculation was not in money, nor speculation as far as lighting was concerned, but speculation as to producing the light. He felt a great deal of sympathy with those who had spent a great deal of money, not to any good purpose. They had put too many eggs in one basket. That had not been their (Metropolitan Company's) principle, but quite the reverse. But it would have been a very grand step in electrical science if they had been able to recognise in those great speculative adventures a great success financially. For the moment that had not been so. But while those failures were, by reflecting more or less upon electric lighting generally disadvantageous, he felt that the Metropolitan stood upon a sound and stronger foundation, because they had proved their position, and they were now, as he said, a paying concern. He expected for the moment that disappointment had more or less affected the general body of the electric light companies' shareholders. It had not shaken his belief in the future of electric lighting, and as London and its suburban population was about the least well supplied of any of the large cities in Europe, he considered that the field was only beginning to be occupied. It was a very wide field, and when it was occupied, there would be a very remunerative field indeed to those who had the courage to watch its progress and stand by it. He would not trouble them by going into the accounts. They had been made up in accordance with the requirements of the Board of Trade. They had them before them; they spoke for themselves, and they had been superintended and proved by their auditors, Messrs. Deloitte, Dever & Co. If any gentleman wished to ask him any question upon the subject, he would be very pleased to answer him. As he had already said, they would want a certain amount of additional capital, because the Paddington system was in addition to their original capital, and they proposed to raise that capital, as it would be only temporary, by the issue of £100,000 of debentures. He did not think they would need to issue more than £50,000 of that amount, but they had better be prepared with an extra amount should they require it. He was glad to take the opportunity of informing them on that subject. They would issue those shares *pro rata* to the shareholders at *par*, and to meet the smallest investors. They thought them very good. They thought they were offering a "plum" to every investor in that electric lighting company, and while they were giving that rate, which he considered rather a high rate under ordinary circumstances, yet the amount was so small, and he wished to show the shareholders that they were in touch and sympathy with them, and wished to encourage them to go on by giving them a little better debenture than they could procure elsewhere. They could not procure a better debenture than the one being offered them. The rate was 5 per cent., and they hoped to pay them off within five years; but at any rate they intended to do so within 5½ years. He had stated before that they had got their present system in working order. There was only the beginning of what he believed would be a very extended system indeed, but they were not going to run any risks; they were going to satisfy themselves thoroughly; to nurse what they had got which was good, and nurse it to a point which would enable them and the shareholders to say, "Let us go ahead." In that case they required money, and in that case they required to deal with that £100,000 of debentures much more extendedly, but in the meantime they did not expect to spend more than £50,000 to enable them to complete their Paddington system. Then they would rest and watch the progress, and he hoped that when he met them on another occasion he would be able to show them that they had again doubled the number of customers. With those remarks he moved the adoption of the report.

Mr. JOHN DENISON PENDER seconded the motion.

Replying to a question by one of the shareholders,

The CHAIRMAN stated that all the residue of the ordinary shares which were offered last September were all taken up.

The report was then unanimously adopted.

The CHAIRMAN moved that a final dividend of 2s. per share on the whole of the ordinary shares of the company be declared, such dividend to be paid on May 14th, 1892.

Sir GEORGE H. RICHARDS seconded the resolution, which was carried.

The CHAIRMAN next proposed, Sir JAMES ANDERSON seconded, and it was carried, that Mr. J. D. Pender, Admiral Sir Geo. H. Richards and Mr. John B. Verity, the retiring directors, be re-elected.

The resolution re-electing the auditors, Messrs. Deloitte, Dever, Griffiths & Co., having been seconded,

Sir THOMAS BAZLEY asked why the accounts showed nothing as to depreciation on their vast expenditure on machinery, and especially on accumulators.

Sir JOHN PENDER stated that he felt that the responsibility of the accounts must always rest upon the auditors, and Mr. Griffiths was there to answer any questions. The principle of reducing and writing off was a sound one, and one which would be observed the moment their capital required it.

Mr. GRIFFITHS, in reply to the observations of the shareholder, said that no reserve had been made for depreciation on machinery or other plant this year. He thought the shareholders would understand that with a company which was practically in its infancy, and which had by no means reached its power of work, it would be hardly fair that the revenue account should yet be charged with any depreciation.

Sir JOHN PENDER said that they had heard the *pros* and *cons*. He could only tell them that when the proper time came for writing gradually off the proper sum for depreciation, they might rest assured that it would be attended to.

In reply to another shareholder, who asked what was the utmost capacity of their present lights,

The CHAIRMAN said that the capacity was now about 250,000 lamps. His own impression was that, judging from the way that people were beginning to understand the electric light—for instance, last year the idea was put forth very strongly by the chairman of the London Company that £1 per light was too little. If, however, the Metropolitan Company had been earning £1 per light upon their 100,000 lights, they would have been paying a very considerable dividend. Now they were going to have a much larger number of lights at smaller rates, their average price was more likely to be 10s. than 20s. If they could get a larger number of customers at a smaller rate, they were building upon a surer foundation. Judging from the figures which came before him from time to time, he would not be at all astonished that they might have a much larger number to deal with than 250,000 lamps.

The resolution re-electing the auditors at the usual remuneration was then put to the meeting and carried unanimously.

A vote of thanks to the chairman and directors was replied to by the CHAIRMAN, who stated that he was a little disappointed because they were not paying the shareholders a large dividend. He had given them the reasons for it, they were perfectly satisfactory to himself, and he saw that as their customers were growing their dividend would be increasing and their expenses not.

Consolidated Telephone Construction and Maintenance Company, Limited.—The directors resolved, at their board meeting on the 5th inst., to recommend to the shareholders at the approaching general meeting that, subject to audit, dividends at the rate of 6 per cent. on the preference and 1 per cent. on the ordinary shares, less income tax, should be paid for the half-year ending March 31st last, making, with the interim dividends, paid, 6 per cent. per annum on the preference shares and 3½ per cent. on the ordinary shares for the year. The transfer books will be closed from the 14th instant to the 16th instant, both days inclusive.

The Swan United Electric Light Company, Limited.—The directors of this company have resolved to pay an *ad interim* dividend at the rate of 8 per cent. per annum, free of income tax, for the half-year ending March 31st, 1892, to be distributed in accordance with the articles of association. The dividend was paid upon the register as it stood on Tuesday last, and the dividend warrants will be issued on May 31st, instant. This works out at 2s. 9d. and two-thirds of a penny per share on the ordinary shares, and 3s. 6½d. per share on the fully paid shares.

South of England Telephone Company, Limited.—The *London Gazette* announces that a meeting of the members of this company is to be held at 5, Moorgate Street, E.C., on June 9th, at 2 p.m., for the purpose of having an account laid before them of the manner in which the winding up has been conducted and the property disposed of, and hearing any explanation that may be given by the liquidator.

Mutual Telephone Company, Limited.—At the extraordinary meetings of the above company, held on April 8th and May 4th, 1892, the following resolution was duly passed and confirmed:—"That the company be wound up voluntarily, and Mr. Edwin Guthrie, of 71, King Street, Manchester, chartered accountant, be and is hereby appointed liquidator for the purposes of such winding up."

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 6th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, amounted to £2,710.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation, May 5th.	Closing Quotation, May 12th.	Business done during week ending May 12th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	49 — 50	50	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½ — 88½	89 — 90	89¾	87⅞
2,849,510*l*	Do. do. Deferred	Stock	11 — 11½	11⅜ — 12⅛	12	11⅛
130,000	Brazilian Submarine Telegraph, Limited	10	10½ — 11	10½ — 11	10¾	10 5/16
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3½	3	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2 3/16	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7¼— 7¾	7¼— 7¾	7¼	...
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	158 —163	159¾	159½
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	5/16— 7/16	¼— ⅜	¼	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅞	5½ — 5⅞	6¼	5⅝
16,000	Cuba Telegraph, Limited	10	10½ — 11½	11 — 12	11	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	16⅝	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½ — 3⅝	3½ — 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11½ — 11⅝	11¾	11½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ — 14⅞	14⅝ — 15	14⅞	14⅝
70,000	Do. 6 p. c. Preference	10	15¼ — 15⅜	15¼ — 15⅜	15½	15 5/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	105 —109	108	106¾
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110 xd	108 —111	110	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛ — 15⅜	15 — 15¼	15⅜	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	103 —106	104	103½
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	103	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —103	100 —103	102¼	101¾
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅜— 6¼	5⅜— 6¼	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1½— 1⅝	1½— 1⅝	1⅝	1 5/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2⅜— 2⅝	2⅝	2 7/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¼— 1⅜	1¼— 1½	1½	1⅜
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10 — 10½	10½— 10⅝	10½	10
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅜	15¼— 15½	15½	15 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	18¾— 19¼xd	19⅛	19 1/16
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7¾— 8¼	7¾— 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	20 — 21	20⅝	20 3/16
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —105	102 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	41	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3⅜— 3½	3⅜— 3½	3½	3½
10,000	Do. do. fully paid	5	5 — 5⅛	5 — 5⅛	5⅛	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7xd	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½— 8	7½— 8xd	7⅞	7⅝
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4¼— 4½	4⅜— 4⅝	4½	4¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	12⅜	12¼
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108½	107⅝
250,000*l*	Do. (issued at 5 p.m., all paid)	...	104 — 106	104 —106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16 xd	1/16— 5/16	...	...
9,000	Reuter's Limited	8	5½— 6½	5½— 6⅓	5½	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅝	8½— 9	8⅝	8⅝
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞ — 8⅛	7⅞ — 8⅛	8⅛	7 15/16
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¾— 4¼	3¾— 4¼xd	4⅛	3⅞
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42⅞
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	1½— 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	104½	103⅞
67,007	Western and Brasilian Telegraph, Limited	15	9½— 10	9½— 10	9⅝	9½
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6 7/16	6¼
30,364	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3½— 4	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	107¼	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited ... ...*	10	1⅝— 1⅞	1⅝— 1⅞	1⅝	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10 7/16	10 3/16
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 —103	99 —103	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —119 xd	115 —119	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100*	98 —102	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— .7	6½— 6¾	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6⅝—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—7 per cent. Preference Shares of £5 (fully paid) 5¼—5⅝.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¾—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5—5½.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅜—⅝.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—½.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 £2 10s. paid), ¼—⅜.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

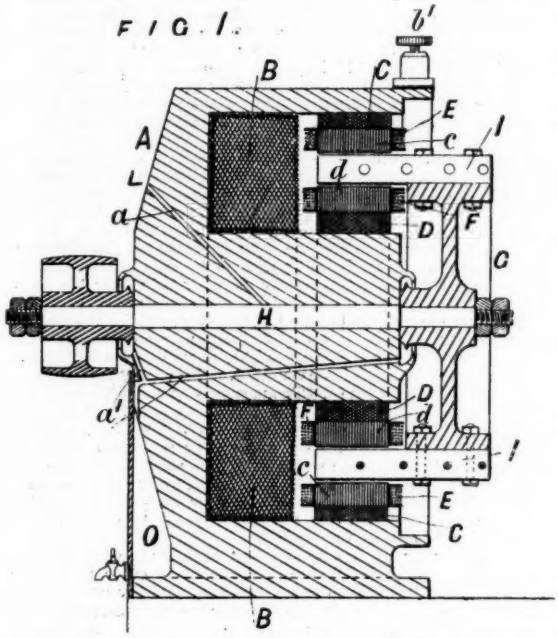
THE PYKE AND HARRIS ALTERNATE-CURRENT DYNAMO.

IN last week's issue we called attention to this machine. Figs. 1 and 2 represent a 100-light alternate-current Pyke and Harris dynamo. The inductors are shown separately.

This machine, which is said to be a wide departure from the usual form of alternator, and which the inventors hold, presents features of great scientific and commercial importance, is designed to work on the inductor principle, primarily designed by Faraday; it embodies the following advantages:—

The whole machine is claimed to be far more solid than any other, and, for the same space occupied, the most energetic, the whole machine consisting of but two castings, iron stampings and coils, and therefore exceedingly cheap and simple to construct. Like machines worked on the inductor principle, it has the advantage of no rotating wire or sliding electric contacts, which greatly simplify the mechanical details. Both the field and armature coils are stationary, and the closed magnetic circuit ensures a large amount of magnetism in comparison with the exciting current, and a further advantage is, that in case of the failure of one or several of

FIG. 1.



the coils, there is a fuse arrangement attached to each connection which melts before the current from the active coils passes into the defective one.

Fig. 1 represents a vertical section, A representing the magnetic mass forming an annular space for the inducing coil and enclosing the latter on three sides. B is the inducing coil, which is surrounded with a mass of magnetic material on its inner and outer circumference and on one face, the said magnetic mass extending beyond the edge of the coil. The said face is then closed, except at a narrow zone sufficient for the rotation of the inductors, by placing on the extensions of the magnetic mass flat annular laminæ, in the form of soft charcoal iron stampings, shown

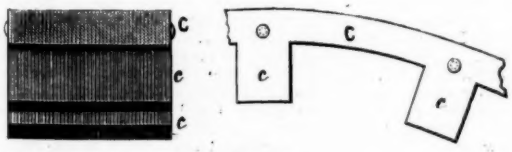


FIG. 3.

in fig. 3, arranged so as to form a continuation of the field-magnet, provided with the necessary polar projections. The laminæ are rigidly fixed to one another and to the field-magnet shown in fig. 3.

Fig. 2 is an end view, the right half being shown with the inductors, and the left half without the inductors. The left half shows also some of the polar projections without the secondary coils. H represents the driving shaft, supported by the magnetic mass and carrying at one end the inductors, while at the other end is fixed the driving pulley. The shaft is lubricated

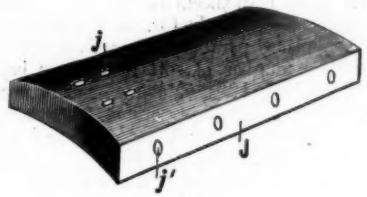
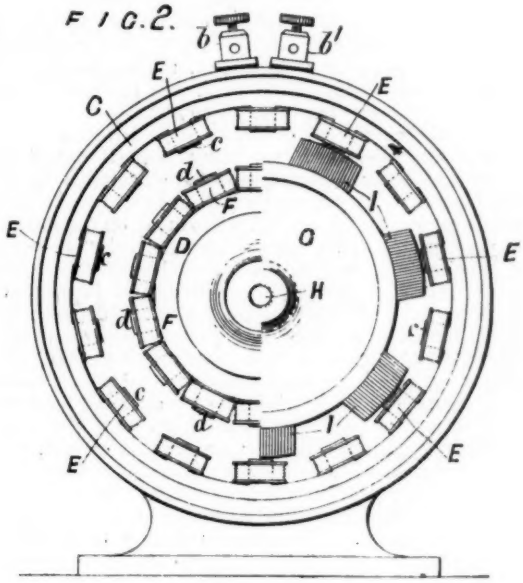


FIG. 4.

by means of a longitudinal groove, which is supplied from a lubricator, L, through an oblique passage, *a*.

Fig. 4 is a perspective view of the inductor, which is of approximately equal breadth to the distance from centre to

FIG. 2.



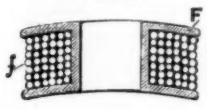


FIG. 5.

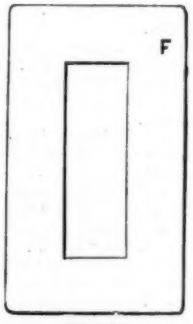


FIG. 6.

centre of contiguous pole pieces. These inductors are subject to great magnetic strains, to resist which requires extreme rigidity. The material of which the conductors are composed requires to be built of the softest iron laminæ, and the laminæ

are fixed by bolts of considerable thickness with strong metal supports. These strengthening parts, placed, as they usually are, in a powerful magnetic field of varying intensity, are favourably situated for the generation in themselves of a considerable amount of eddy currents. One important point of Messrs. Pyke & Harris's invention consists in interleaving strengthening metal formed of thin sheets between the laminæ of soft iron which constitutes the inductor. In the present machine, the inductors are placed parallel to the axis of the rotation of the carrier. The number of soft iron plates between the pair of strengthening plates, of course, varies according to requirements. The plates are separated from each other by thin sheets of paper, as is usual, hardened steel sheet being used for the strengthening laminæ.

Fig. 5 is a section, and fig. 6, a face view of one of the reels carrying the secondary coils.

The inductor carrier, which is of gun-metal, is shown at G in fig. 2, mounted on one end of the driving shaft, H.

Electric currents are produced by revolving the magnetic inductors in proximity to the magnet, which is provided at both poles with polar projections, serving as cores for the conductors in which the current is to be induced, the object of the inductors being to complete the magnetic circuit alternately through each set of polar projections.

An even number of polar projections are employed, and the revolving inductors are arranged so, that in proportion as one pole is being demagnetised, the magnetism of the other poles increases, and *vice versâ*, thus the total magnetic effect being always approximately constant.

The induced current conductor is so arranged that the polar projections which are being magnetised and those which are being demagnetised, have a similar inducing action upon it, the magnetising of one set of polar projections thus increasing the effect produced on the same wire by the demagnetisation of the other set of polar projections.

This invention may be used in machines for the production of single or many phase alternating, or for continuous currents, the polar projections and the induced current conductors being readily arranged for any desired disposition (in the case of inductor machines, being so arranged that the induced current conductor may be wound on the polar projections).

Messrs. Pyke and Harris state they are aware that others have constructed dynamos in which the conductor for the inducing current and that for the induced current, as well as the magnetisable mass, are stationary. They do not therefore claim this principle, but consider the great feature of novelty in their machine to consist in the arrangement of the pole pieces. The apparatus is only 15 inches wide, 20 inches long, and 21 inches high over all, excepting the pulley, and it weighs complete 6 cwt.

ELECTRIC AND CABLE RAILWAYS IN THE METROPOLIS.

Parliamentary Inquiry.

On Monday, at noon, the Joint Committee of the House of Lords and the House of Commons recently appointed on the subject of electric and cable tramways in the metropolis, met in Room A of the Upper House, Mr. Stansfeld presiding. The other members of the committee were:—Lord Thring, Lord Barrington, Lord Lauderdale, Lord Strafford, and Lord Kelvin, and Mr. T. H. Bolton, Mr. J. S. Gathorne-Hardy, Mr. Whitmore, and Mr. Story Maskelyne.

The Chairman, before evidence was taken, said he might mention that the committee proposed to meet again on Thursday, but had not yet decided on what days they would meet in subsequent weeks; that would be settled on Thursday.

The Remembrancer (Mr. Goldney) in describing the schemes before Parliament, said there were six in all, and that the railways were to be worked by electricity or by cables. The first was the Central London Railway—a Bill which proposed a modification of the scheme that was passed by Parliament last year, and which started at Shepherd's Bush. It was an electric line, and went along Uxbridge Road, Oxford Street, Holborn, and Cornhill. The present Bill was to make a slight deviation, and take the line up Liverpool Street to the terminus of the Great Eastern Railway Company. The motive power in this case was electricity. The next scheme was that of the Waterloo and City Railway, which proposed to make a line from the open space between the Mansion House, along Queen Victoria Street, just escaping Blackfriars Bridge, and into Waterloo Station; that was to be an electric line also. The next was the City and South London Railway Bill, which was an extension of an existing line, and to empower the City and South London Company to make an underground railway as far as the Angel at Islington—a district that was without adequate travelling facilities. Then they came to the Great Northern and City Railway Bill, which proposed to incorporate the Great Northern and City Railway Company, and empower them to construct a railway from the Canonbury branch of the Great Northern Railway, near Finsbury Park, to the City. The company proposed to make a large bore underground, as distinguished from the ordinary bore, so as to accommodate the ordinary rolling stock of their line and of the country. All of the six railways proposed to have the regular gauge, but in this case there would be a larger tube—large enough for the ordinary traffic. In the Central London Railway there was to be one large new station, and the station at Liverpool Street; in the Waterloo and City scheme there was one at the terminus at the Mansion House, one in the City near the existing station, and one at Moorgate Street, with two or three stations outside the City. The route was a very suitable one, as there was a very great number of people who went to Waterloo every morning, and to whom the line would offer many advantages. Colonel Heywood, who had advised the City in such matters for many years, had made a favourable report on the subject, which would be read later on, and there had been a similar report from Mr. John Wood Barry. These gentlemen could give more details on the subject than he (Mr. Goldney). In the opinion of the corporation committee it was desirable that the size of the tubes should be uniform, but they passed no opinion as to whether the tubes ought to be of any particular dimensions. He would lay before them the report of the corporation engineer. The corporation committee also said that no part of the public way should be appropriated without a corresponding advantage falling to the public. Another point to which attention had been directed was vibration. If injury by vibration took place, there should be something to meet it.

Lord Thring asked if the passing of the Bills as they stood would not prevent the success of any claim for damage by vibration.

The Remembrancer could not answer that, but said it had been stated that there would be no vibration, and engineers had come to the opinion that there would be none. There had also been a very long report on the subject of a proposed large railway station near the Bank in the Central London Bill. There was a suggestion that the whole of the space should be used for a large central station and for subways. A scheme like that could only be carried out at very great expense and much public inconvenience, and on that subject, no doubt, the committee would hear further later on. The question of the best or most favourable line of route had been discussed. If railways were to be made along the streets, as now proposed, they should not be carried under houses, except for some specific object. The schemes did not conflict one with another, and the different companies, instead of acting in opposition to each other, were in complete harmony. He could not say precisely how near the lines would run to St. Paul's, but a special clause had been inserted in the Bill to protect the cathedral and other property, and he thought he might say that the St. Paul's authorities were perfectly satisfied with the Bill. The lines were not, he thought, above one another in any case, but they ran alongside of each other. He fancied that the Great Northern line was the highest. The idea was to make it meet the traffic of the people who went to and from the city, not for passengers with luggage, which might be carried if necessary, however. He was not engineer enough to say whether or not there would be vibration caused by proposed railways, if they went lower than the level of 10 feet beneath the undisturbed London clay. The proposal was to use tubes of a size that would admit ordinary railway traffic, though it was not intended that the latter should be conducted on the new lines; these were for city traffic.

Mr. J. H. Greathead said he was joint engineer to all of the proposed railways, two of which were extensions, the other four being new lines. The first question was whether an underground railway could be worked by electricity, and whether the proposed lines would be capable of meeting the demands made upon them. He had no doubt whatever as to the capacity of electricity to deal with any percentage of the traffic of the line. All the lines were to be of the standard gauge, viz., 4 feet 8½ inches, but were not intended to take traffic through; they were to deal with the ordinary traffic of London.

The Chairman: You think they would be capable of taking up the traffic of the main lines, if necessary?

Witness: Yes; the Great Northern is intended to take up ordinary trains from Finsbury Park. Electricity is capable of carrying on that line. The St. Pancras and Charing Cross Railway are proposing to run trains capable of carrying about 350 each. They are for short distances. There is no outside traffic to interfere with the line; the trains, if necessary, could be run every three minutes; but the Waterloo and City line, with a five minutes' service, would carry 15½ millions per annum, and with a three minutes' service nearly 26 millions per annum.

Mr. Whitmore: What is that a day?

Witness: I have not made a calculation. On the Baker Street line, presuming each train is half-full only, a five minutes' service would meet the needs of 24½ millions per annum; and 26 millions would be about 40,000 passengers per day. The question of the working of the City and South London Railway came up about a year ago. The trains weighed about 40 tons each, the gradient was very severe (1 in 30), and the curves were very sharp; but the line has been worked very successfully. The trains there have, of course, been delayed, sometimes, like others, but I think the service will compare favourably with suburban service generally, especially in foggy weather. It should be remembered that owing to the higher temperature we have no such thing as fog on the electric railway. The failures that there have been have all been due to one cause, which has been met.

The Chairman: Do you say that the number of passengers you could carry would be as great as could be dealt with on ordinary lines?

Witness: In these tunnels, although they are smaller than those of the present underground railways, we can carry quite as much as they do on the ordinary railway, and more than is carried on the Metropolitan. Of course, these new lines being placed at a considerable depth, will not interfere with any other railways that now exist,

or that may be required in course of time. The cable system is a method of running carriages by endless or continuously running cables. It has been adopted successfully in many places—in New York, Chicago, San Francisco, &c. There would be no difficulty in running a cable at a rate of 15 or 16 miles an hour, and that would give on a line like those we contemplate, an average speed of 13 miles an hour, which is considerably in excess of the speed attained in the inner circle of the Metropolitan Railway, which is 11 miles an hour. The system is for the trains to attach themselves to, or detach themselves from the cables by means of grippers, as they wish to start or stop. The advantage of the cable system is that you save power, inasmuch as your motive is not to be stopped every time you stop the train; you merely let go of the cable. On the inclines the trains ascending and descending will balance themselves; and thus they will be run very cheaply. The gripper grips the cable gradually at the start, and when they wish to stop they let go, and put on the brakes.

The CHAIRMAN: How would you prevent collisions on the line.

WITNESS: We have a very simple system of automatic signals, so that the men on a train know just where the train immediately in front is; and if anything is wrong they would at once detach themselves from the cable. This system is already in practice with success. There is a cable railway on Brooklyn Bridge on which this system is used, and which carries as many as 35,000 passengers per hour. The Hampstead line would certainly be worked by cable. I don't think there will be any appreciable vibration on the surface, either by cables or electricity. I have made experiments on the existing South London Railway, and have had the most delicate tests made in the tunnels themselves, and it is impossible to detect any vibration. The tunnels will be at least 50 feet below the surface; some of them will be very much deeper. Generally speaking, the whole of the railways will be of the same depth.

The CHAIRMAN: Are the rails laid in any novel manner at all?

WITNESS: The rails are laid without ballast, and it will be very easy to keep them in repair.

The CHAIRMAN: Are all the lines on the same gauge?

WITNESS: Yes, all on the same gauge; but there is some difference in the diameter of the tunnels. Eleven feet 6 inches is the size of most of the tubes, but some are to be 12 feet. It is practically the same thing, however. The Great Northern line, which is an exceptional case, would be 2½ miles long. Eleven feet 6-inch tunnels would take ordinary railway carriages quite easily, with the doors shut and slightly smaller wheels. There would have to be somewhat different carriages, with entrances at the ends, like those on the elevated railroads of New York and Brooklyn. There is no object in having larger tunnels, unless you are going to form junctions. I don't think the junctions are either desirable or within the limits of the scheme.

Lord THRING: What is to be the width of the carriages?

WITNESS: About 9 feet. I think it is desirable that the tubes should not be made capable of taking the ordinary traffic of railways. The internal traffic of London would be served very much better if it were not interrupted, as at present, by trains already fully loaded coming in from the outside. You have trains coming in quite full, and going straight on. They are not convenient for the internal traffic of London. In 1890 evidence was given on the point, and it was said that these lines should be capable of taking the ordinary traffic; but afterwards we came to the conclusion that it was best to have the tunnels of the size now proposed (11 feet 6 inches), and not to take the ordinary trains. These railways could carry luggage, if necessary. The stations are always quite level, the inclines being between. The brakes will stop movements caused by momentum, and we are not afraid of accidents through the steepness of the gradients. There is a separate tunnel for each line, so that there can be no difficulty about ventilation. On the South London the ventilation is very good, and there is no electrical disturbance caused by it. For each line there would be a separate generating depôt, and points have been chosen where the dynamos could not be a nuisance to anyone in the neighbourhood. The working of an ordinary railway does cause noise and vibration, but this would not be nearly so bad. It might become a nuisance to a house a few feet away, but not to the neighbourhood.

Lord THRING: Would you accept a clause providing for compensation to be paid in case the line is a nuisance to anyone?

WITNESS could not answer the question.

Lord THRING: Do you provide any protection or compensation for persons in houses immediately adjoining?

WITNESS: Yes; but there can be no nuisance. On the cable principle gradients are almost immaterial. There would be very little noise with either cable or electricity. The dynamos on the South London line are perfectly silent. It is the steam engines that make a noise. The estimated cost of the Waterloo and City line is £500,000, to which has to be added the cost of the electrical equipment, probably another £200,000, including rolling stock. It is a mile and a-half in length, and the electric trains would be capable of running from Waterloo to the City in 3½ minutes. It would satisfy a want that has existed for many years. The Baker Street line, about 70 feet below the surface, was about 3 miles long; the average speed on it would be about 14 or 15 miles an hour, and the time occupied from Baker Street to Waterloo would be about 12 minutes; total estimate £990,000, inclusive of rolling stock. The Hampstead line, with stations at three points between Charing Cross and Hampstead station, would cost £1,250,000. It will probably be worked by cable; and there is a junction, and it is about 50 feet below the surface. The South London Railway extension would cost about £706,000, being some 2¾ miles in length. The portion already made and in use was 3 miles in length, and cost £800,000. The Central London Railway (a small supplementary one) would be about three-quarters of a mile in length, and would cost some £150,000. The last line, the Great Northern and City Railway, went underground about 2½ miles, the estimated cost of which was £1,200,000. The surface of the street would not be broken, and no public inconvenience would be caused by the construction of any of the proposed lines. In 1867, when the Metropolitan Railway was only 4½ miles long, and not extending, as at present, to 38 miles, it carried some 23½ millions of passengers, while last year it carried 87 millions. In New York the elevated railways, on the other hand, though not able to take ordinary trains, and without junctions, in 1890 had a length of 32½ miles, and carried 188 millions of passengers—any one train being capable of seating 240 passengers only. As facilities have from time to time been provided, the traffic in London has increased out of all proportion to the growth of the population. In 1864, when the population was 2,940,000, the number of fares paid in the Metropolis was 54,370,000; in 1874, when the population was 3,420,000, the number of fares paid by passengers was 155,160,000; in 1884, when our population was 4,010,000, no less than 311,880,000 fares were paid; but in 1889, when the population of London was 4,350,000, the fares paid were 429,990,000. The ratio of population to passengers was:—1864, 1 in 18; 1874, 1 in 45; 1884, 1 in 78; 1889, 1 in 99! While electric underground lines did not disfigure the streets as did the elevated railroads, and while they were quicker, healthier, and more comfortable, they were also more economical in construction, and gave a rateable value to that which at present had no value, viz., the lower sub-soil of the streets, and they therefore tended to reduce the rates.

Mr. BIRCHEM said the promoters were prepared with scientific evidence, if the committee desired it.

The CHAIRMAN said they would take one such witness on Thursday.

Mr. PERKS asked to be heard on behalf of the Metropolitan Railway.

The CHAIRMAN: At the next sitting we will hear you.

Mr. OAKLEY, representing the Great Northern Railway, intimated that he, too, had witnesses to call, if the others were going to be heard.

Mr. GREATHEAD, having explained the construction of the tunnels of the electric railway, and showed how simple, cheap, durable, and safe they are, with their iron tubing, said that however deep they were, they remained watertight, so that, even when being made, no pumping was required.

The committee sat till about 4 o'clock.

THE CHICAGO EXHIBITION.

PRELIMINARY ADDRESS OF THE COMMITTEE ON AN ELECTRICAL CONGRESS IN CONNECTION WITH THE COLUMBIAN EXPOSITION OF 1893.

IT is eminently fitting that at suitable times and on suitable occasions men in all departments of science and industry should come together for interchange of thought, and for the discussion of subjects that have to do with the great activities of life—practical and intellectual.

What more fitting time to hold a series of congresses than during the great World's Columbian Exposition, at Chicago, in 1893?

In pursuance of this object the World's Congress Auxiliary of the World's Columbian Exposition has been organised, under the support of the Exposition Corporation, and has been recognised and approved by the government of the United States.

Under this organisation committees have been appointed to organise a series of congresses. Among others, a general committee, consisting of a local committee and an advisory council, selected from men eminent in the science, both in this and foreign countries, has been appointed by the World's Congress authorities to organise a World's Electrical Congress, to be held at Chicago sometime during the summer of 1893.

The movement is, as yet, in a formative stage, and much thought must be given to it before a detailed programme can be formulated.

It is the intention of the general committee to so organise the congress that the greatest good to the science and to all interested in electrical progress may be attained.

It is desirable that the work of the congress should be divided into sections, the number of which will be determined after consultation with the advisory council.

The first and most important section should give its time and thought to the more purely scientific phases of the subject, such as the revision of the existing electrical units, and the addition of such others as the state of the science may require.

Other sections should be devoted to the more practical questions of applied electricity.

In addition to the meetings of the various sections, there will be general meetings, where all will come together to listen to papers from men eminent in the science from all parts of the world.

An audience room will be furnished, where such general meetings of the congress will be held, in connection with which will be smaller rooms, suitable for the meetings of the various sections.

In order that their conclusions may have the authority both of scientific ability and of official sanction, the members of the first or scientific section, should be appointed by the respective governments from which they come.

The delegates having this very important work in charge should represent the best talent from all parts of the world, or from such countries as, by reason of achievements in the domain of electricity, are entitled to a voice.

We invite the hearty coöperation of all persons interested in electrical progress, not only by any suggestions they may have to make, but also by their presence at the congress in 1893.

Already there is a lively interest felt in the matter, in this and other countries, for the idea of holding an Electrical Congress, at the time of the World's Fair, is not a new one either to European electricians or to the profession in this country.

Several associations of electricians have suggested it; for three years past the American Institute of Electrical Engineers has had an active committee on this subject; and at the Electrical Congresses of

Paris (1889), and Frankfort (1891), its delegates extended a formal invitation to their European associates to come to America in 1893.

Since those invitations were extended, the present authorities have been appointed by the World's Congress Auxiliary of the World's Columbian Exposition. When these authorities presented the matter officially to the Institute, they immediately saw the fitness of having the congress held under the auspices of the World's Fair; and by a formal and unanimous vote of its council and special congress committee, it has pledged itself to give all possible support to the agencies now entrusted with the responsibility of making a success of the proposed Electrical Congress, at Chicago, in 1893.

It is the hope and expectation of the committee on the electrical congress that other electrical associations at home and abroad will give us the same hearty co-operation.

The time of meeting will be most auspicious, as the representatives of the world's best thought and best work will be centred here, and the congress will meet under the shadow of the greatest palace of electricity the world will ever have seen.

Other announcements will follow this one, from time to time, as the work of organisation goes on.

A partial list of the advisory council of this committee is appended.

All communications in the way of suggestions or otherwise, should be addressed to the chairman,

ELISHA GRAY,
Chairman Committee on Electrical Congress,
Highland Park, Ill.

ROBERT C. CLOWRY, *Vice-Chairman,*
Chicago, Ill.

HENRY S. CARHART, *Secretary,*
Ann Arbor, Mich.

World's Congress Headquarters, Chicago,
March, 1892.

THE FOLLOWING PERSONS HAVE BEEN APPOINTED TO CONSTITUTE, WITH OTHERS TO BE HEREAFTER NAMED, THE ADVISORY COUNCIL OF THE WORLD'S CONGRESS OF ELECTRICIANS.

Sir William Thomson, P.R.S. (Lord Kelvin), The University, Glasgow, Scotland.
W. H. Preece, F.R.S., Electrician-in-Chief, General Post Office, London, England.
Prof. W. E. Ayrton, F.R.S., City and Guilds of London Institute, Central Institution, Exhibition Road, London, S.W., England.
Lord Rayleigh, Terling Place, Witham, Essex, England.
Prof. S. P. Thompson, D.Sc., London, England.
Prof. E. Mascart, College de France, No. 176, Rue de l'Universitie, Paris, France.
E. Hospitalier, No. 6, Rue de Clichy, Paris, France.
Dr. Werner Siemens, Berlin, Germany.
Prof. H. von Helmholtz, Berlin, Germany.
Prof. Gallileo Ferraris, Turin, Italy.
Joseph Kareis, K. K. Baurath, Wien II., am Tabor 6, Austria.
Prof. Dr. Weber, Ecole Polytechnique, Zurich, Switzerland.
Prof. E. Gerard, Inst. Electro-Tech. de Montefiore, Liege, Belgium.
Prof. A. Repman, Moscow, Russia
Prof. A. Stoletow, Moscow, Russia.
S. Yslas, de los Telegrafos Federales, City of Mexico, Mexico.
Director General of Telegraphs, Madrid, Spain.
Prof. Geo. F. Barker, M. D., University of Pennsylvania, Phila., Pa.
Prof. C. F. Brackett, College of New Jersey, Princeton, N.J.
Prof. Henry A. Rowland, Ph. D., Johns Hopkins University, Baltimore, Md.
Prof. T. C. Mendenhall, LL.D., Director U.S. Coast and Geodetic Survey, Washington, D.C.
Prof. B. F. Thomas, Ohio University, Columbus, Ohio.
Prof. Thomas Gray, Rose Polytechnic Institute, Terre Haute, Indiana.
Prof. A. E. Dolbear, Tufft's College, College Hill, Mass.
Prof. John Trowbridge, D.Sc., Harvard University, Cambridge, Mass.
Prof. F. E. Nipher, Washington University, St. Louis, Mo.
Prof. Sidney H. Short, Cleveland, Ohio.
Prof. Henry Morton, Stevens Institute, Hoboken, N.J.
Prof. Brown Ayres, Tulane University, New Orleans, La.
Prof. John E. Davies, LL.D., University of Wisconsin, Madison, Wis.
Prof. A. P. Carman, Purdue University, Lafayette, Ind.
Prof. Lucian I. Blake, Ph.D., University of Kansas, Lawrence, Kan.
Charles F. Brush, Cleveland, Ohio.
Dr. Channing, Pasadena, Cal.
Michael Pupin, Ph.D., Columbia College, New York, N.Y.
Prof. Elihu Thomsor, Lynn, Mass.
Franklin L. Pope, Elizabeth, N.J.
George M. Phelps, New York, N.Y.
Frank J. Sprague, New York, N.Y.
Edward Weston, Newark, N.J.
Prof. William A. Anthony, Manchester, Conn.
Louis Duncan, Ph.D., Johns Hopkins University, Baltimore, Md.
Prof. Alex. Graham Bell, Washington, D.C.
Francis B. Crocker, Columbia College, New York, N.Y.
Nikola Tesla, New York, N.Y.
Thomas A. Edison, Ph.D., Orange, N.J.
Carl Hering, Philadelphia, Pa.
T. Commerford Martin, New York, N.Y.
Prof. Edward L. Nichols, Ph.D., Connell University, Ithaca, N.Y.
Prof. Edwin J. Houston, Central High School, Philadelphia, Pa.
Dr. William E. Geyer, Stevens Institute of Technology, Hoboken, N.J.
A. E. Kennelly, Orange, N.J.
Thomas E. Lockwood, Boston, Mass.
Louis Bell, Ph.D., New York, N.Y.
Prof. Charles R. Cross, Mass. Institute of Technology, Boston, Mass.
George A. Hamilton, Elizabeth, N.J.
Ralph W. Pope, Elizabeth, N.J.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

(*Concluded from page 586.*)

The following measurements of red and green light from different sources have been made by Prof. L. Weber, of Breslau,* taking incandescent platinum as unity. Taking the Violle platinum unit at 18·5 standard candles, the author has converted them into candles per square inch and candles per square centimetre, and has added six other sets with white lights only, from his own observations.

	C.P. per sq. in.		C.P. per sq. cm.	
	Red.	Green.	Red.	Green.
Platinum (Violle standard)	120	120	18·5	18·5
Sun's disc	487,000	1,000,000	75,500	155,000
Sky, near sun	120	120	18·5	18·5
Albo carbon on edge ...	73·5	60·7	11·4	9·4
White paper, horizontal, exposed to summer sky, noon	16·5	35·2	2·56	5·45
White paper, sun 60° high, paper facing sun	8·25	17·2	1·28	2·67
Albo carbon flat	10·5	8·7	1·63	1·35
Argand	6·8	5·24	1·05	0·82
Black velvet, summer sky, noon	0·0333	0·07	0·0052	0·0109
White paper, reading without straining	0·0018	0·0024	0·00028	0·00037
	White.		White.	
Sperm candle	2		0·31	
Moon, 35° above horizon ...	2		0·31	
„ high	3		0·46	
Batswing (whole flame) ...	2·25		0·35	
Methven standard	4·3		0·666	
Crater of electric arc ...	45,000		7,000	

The foregoing considerations about continuous-current arcs point to the value of a long arc, a small and, if possible, a pointed negative carbon; but these must without hesitation be sacrificed to perfect steadiness. For outdoor work the uniformity of distribution is not much affected by the shadow of the lower carbon; indeed, it may perhaps be advantageous, for there is a fair amount of stray light immediately beneath an arc lamp; and if the lower carbon could be dispensed with there would be an overpowering illumination, which would make street lighting much more irregular than at present, unless very high posts were used. But for railway stations and for such places as the British Museum reading room, some improvements might be made in this direction. Experiments have been made with a carbon rod surrounded by a carbon tube, arranged pointing downwards, and the arc has been made to travel round by magnetic rotation. The rod should be positive, as the end surface of the tube would be too large to keep incandescent, unless with a very large current. The Jamin candle, a modification of the Jablochkoff, and the Rapieff and Hedges lamps, are examples of efforts in this direction.

Several attempts have been made to improve the arc by adding volatile substances, or by introducing gas through a hollow carbon. The most successful of these appears to have been the Saunderson method of using hydrocarbon by means of a wick, but nothing has been heard of this for some time. The only good effect that can be expected is the production of a long arc which will reduce the shadow of the lower carbon; and it is likely that the temperature of the crater will be reduced by the presence of any substance less volatile than the best carbon. With a scientific but misguided regard for truth, the candle-power of arc lamps has been reduced to its "mean spherical" value by many authorities. An easy way to arrive at this is to cut out a piece of card to the shape of a candle-power diagram, such as figs. 1, 2, or 3. By balancing this on a pencil, on a line parallel with the perpendicular axis, the distance of the centre of gravity from the axis may be found. The area may be measured with a planimeter, or by comparing the weight of the card with that of the rectangle out of which it was cut, or by treating the curve as being composed of half an ellipse and part of a parabola.† Then, measuring the distance of the centre of gravity from the axis, and multiplying this by 2π times the area, the solid contents of the figure of revolution of the curve about its axis are obtained. The mean spherical candle-power of the arc is equal to the radius of a sphere having the same solid contents. As so little light is emitted above the horizontal, it would seem quite as useful to take the mean hemispherical candle-power. But we not only learn nothing fresh, but are likely to be misled, for a light giving the same mean spherical candle-power would not be nearly so useful as an arc. The mean spherical candle-power has been found by M. Rousseau by plotting to rectangular co-ordinates.‡ But the method is not much easier, and it seems better to retain the polar curve, which has a geometrical meaning.

Since there is little or no difference in the light giving properties of arc lamp carbons, the various qualities differing mainly in

* *Journal für Gasbeleuchtung, Electrician*, Vol. xxv., p. 404.

† Area of ellipse = minor axis × major axis × $\pi/4$. Area of parabola = base × $\frac{2}{3}$ height.

‡ Eric Gerard, "Leçons sur l'Electricite," Vol. ii., p. 298.

homogeneity and rate of burning, and since there must be a definite relation between the watts expended and the area of the crater, or the candle-power, it seems preferable to denominate the size of arc lamps by the number of watts expended. There is no reason why the maximum candle-power at the best angle should not be given, if the candle-power be mentioned at all; but the carbons should be very carefully centred, and the test should be made either with several photometers simultaneously, or with a lamp revolving like a meat jack. The nominal 2,000 candle-power which 10-ampère arc lamps are sometimes supposed to give is a perfectly unjustifiable convention, and has been very properly characterised as "a fine old crusted lie."

It might be imagined that, since an ordinary opal globe surrounding an arc lamp does not appear to differ greatly from a uniformly luminous sphere, the candle-power at different angles would be very much more uniform. This is not the case. Fig. 12 has been derived

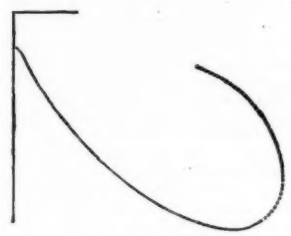


FIG. 12.

from the measurements of the illumination on the surface of the street by an arc lamp in Cornhill, an opal globe being used; the dotted line is assumed. Fig. 13 is a pair of similar curves, derived from measurements made in Queen Victoria Street with arc lamps enclosed in moulded glass.

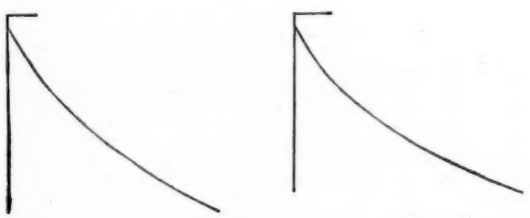


FIG. 13.

Owing to the difficulty of comparing the light from an arc lamp with the light of a candle, on account of the difference of colour, it has been a common practice to make photometric measurements with red and with green glasses, and elaborate tests have been made by Prof. Nicol and others throughout the whole range of the visible spectrum. The red and green glasses allow rather more definite readings to be made; but by a little practice with a photometer, which allows very free and rapid changes to be made by the oscillation of a lever or a handle, very much greater accuracy may be obtained than with an instrument in which a screen or a lens has to be moved on a slide until a balance is effected. But the green and red measurements having been taken, no one has yet suggested what is to be done with them; neither the mean, the sum, nor the product has any physical meaning, and the two readings are generally given side by side. For purely scientific work, where the light is treated as radiant energy, either the whole spectrum should be measured and compared with a standard, or the luminous rays should be carefully separated from the dark heat rays, and the radiation measured as a whole. Such measurements have been made by H. Nakano and by Louis B. Marks,* and form a very valuable contribution to our knowledge of the efficiency of the arc.

It has been shown by M. A. Crova† that the portion of the spectrum lying near $\lambda = 582$ gives a true measure of the total candle-power of a light. Prof. E. L. Nichols‡ finds $\lambda = 600$ to be the position. For a considerable range of temperature the ratio between the intensity of this part of the spectrum is practically identical with the ratio of the candle-power of two lights.

The use of the green and red measurements, besides facilitating the work of the photometrist, is to compare, in a rough way, the whiteness of the light under observation with a standard light. The measurements of M. de Nerville§ afford some information as to the colour of the arc lamps at the Hippodrome, the glow lamps at the Opera House, and the gas lighting at the Post Office at Paris. But this information can be obtained only in the arbitrary terms of the ratio of the red reading to that taken with the green, when these two are equal, and the ratio is unity. This was the case with the Edison lamps at the Opera House, but it tells us nothing. A complete luminosity curve for each glass throughout the spectrum would be required to explain these readings; but even then the resultant luminosity curve could not be derived. Some idea of the quality of the light thus measured may be determined by comparing the ratio of the red and green components of some standard light. Such a comparison may be made with measurements made by M. de Nerville on the illumination produced by bright sunlight shining on a window with white blinds. The ratio of green to red in this particular photometer was about 3·5 to 1 for sunlight at 4 o'clock in the afternoon on May 1st, 1890.

Captain Abney has made many investigations on the colour of daylight, and a chapter is devoted to this in his popular book on colour measurement and mixture. In searching for a standard light of uniform colour he found nothing to equal that which is given from the crater of an arc. This is very satisfactory to electrical engineers, but it gives no definite information as to the real quality or degree of whiteness of the light. The popular idea, and one which is very firmly fixed, is that arc lamps give a bluish light, sometimes rather violet; that it shows up certain colours in a sickly or unnatural manner; and there is a wide-spread belief that it not only acts injuriously on the complexion, but pierces cosmetic embellishments. These ideas are of so serious a nature that the author ventures to discuss the quality of the light of the electric arc; since, although it is not a strictly electrical matter, it has a rather important aspect, in so far as it is a more or less unpopular feature of electric lighting.

The only standard of pure white light which we have is that of the diffused light of a summer day. Artists are familiar with the fact that direct sunlight is yellowish,* even on the clearest days; and that a blue sky, on the other hand, gives distinctly blue light; and that both of these must be avoided, or a picture painted under such lights will appear too cold or too warm when hung in a diffused light. Captain Abney has found that at different seasons of the year and at different times of the day very considerable changes occur in the colour of sunlight, owing to the absorption of bluish light by the atmosphere. It does not, however, appear impracticable to the author to fix on a fairly typical degree of whiteness, such as that of chalk, whiting, or alumina exposed to diffused light in summer time. A luminosity curve of the spectrum of such light would be a standard. Compared with such a white, or, indeed, by a very rough comparison with ordinary daylight in clear weather, the arc gives a distinctly pale primrose light, rather warmer than straw-yellow, and, to the author's eye, distinctly yellowish, in spite of the pale violet flame of the arc, which with inferior carbons occasionally flares up at irregular intervals. It is no use telling an unscientific person that the light is not blue, but pale yellow; he will answer, "It appears to me to be blue or violet, and, therefore, to me, and to 99 people out of a 100, it *is* blue or violet."

Three reasons can be brought forward to explain this optical illusion. After dusk we are accustomed to the use of strongly yellow and even orange-coloured light of gas, lamps, candles, or, glow lamps, and our own idea of whiteness is lowered. The whitest thing that we can see is a sheet of white paper, which is, of course, no whiter than the yellow light of the lamps; we imagine that it *is* white, and thus a false standard of white is obtained. When a really whiter, though not perfectly white light is introduced, it naturally seems to be bluish compared with the false standard of white. Whether our idea of white really becomes altered is a psychological question which it would be out of place to discuss in the present paper. Secondly, after dusk the blue-seeing nervous elements of the eye (on the Young-Helmholtz theory) are allowed to rest, while most of the work falls upon the red and green-seeing elements. These latter become wearied, while the former are in a more highly receptive condition than during the day. As soon as a light containing a tolerable proportion of blue light is seen, it naturally appears to be more blue than white. The third suggestion is based upon a result of Captain Abney's researches, which show that for the most feeble illuminations no colour can be distinguished, and that the first colour which can be discovered is blue. He finds, and is supported in this by Lord Rayleigh, that the faintest light appears of a greyish-green colour; and Captain Abney attributes the apparent colour of moonlight to this cause. The author does not attach much importance to the application of this phenomenon as an explanation of the colour of the light of arcs, but it is worthy of record in this connection. When the eye passes gradually from daylight into electric light without seeing any distinctly yellow light, the sensation of blueness is rarely, if ever, observed.

It would be easy to humour this optical illusion, as is done at the British Museum reading room, by the use of screens of yellowish glass; but a much more important consideration is the value of the arc light for the proper discrimination of colours; and though it is found in dye works that most colours can be matched with a good 15 or 20-ampère arc, there appears to be no reason why a perfect reproduction of a standard daylight quality of whiteness should not be obtained—at all events, with arc lamps, if not with glow lamps. The public would not be ready to believe it: they would call such a light bright blue; but that does not matter much. As the idea did not occur to the author until the autumn of last year, he has been unable to make experiments with summer daylight; but as it would be a

* American Institute of Electrical Engineers, May 21st 1890, *Electrician*, Vol. xxv., p. 150.

† Electrical Congress, Paris, 1889.

‡ American Institute of Electrical Engineers, 1890, *Electrician*, Vol. xxiv., p. 225.

§ Société Internationale des Electriciens.

* Dr. W. J. Russell and Captain Abney, on the other hand, say: "The light from a sky which is cloudy has very much the same composition as sunlight itself, as we have repeatedly proved." "The proportion of blue rays in sunlight near mid-day in May is very nearly the same as the standard light" ("the white hot crater in the positive carbon pole of the electric light.")—"Report on the Action of Light on Water Colours," c. 5,453, 1888, pp. 23 and 69.

misfortune if it were patented, he takes the present opportunity of describing the principle.

The full line in fig. 14 is the luminosity curve for the light of the positive pole of an arc as determined by Captain Abney. The horizontal scale is the length of the spectrum, and the letters refer to the well-known line. The ordinates are a measure of the brightness of each part of the spectrum. The dotted line is the luminosity curve for sunlight in May, from the same authority. Fig. 15 shows the difference between these two curves. The portions which lie below the horizontal line represent the excess of orange and greenish rays in the arc, and the portion which lies above the line represents the deficiency in blue rays. Such a deficiency has the same effect on the eye as an excess of yellow, and the whole effect is distinctly more yellow than sunlight. The light of a glow lamp at ordinary incandescence is almost exactly the same as that of gas. Fig. 16 gives the luminosity curves of arc and gas; and fig. 17 shows the difference which, when the curve of gaslight is reduced so as to fall wholly within the arc curve, as in fig. 16, consists of a deficiency which increases rapidly towards the blue.

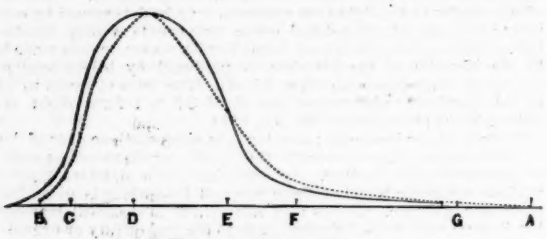


Fig. 14.—Arc and Sun.

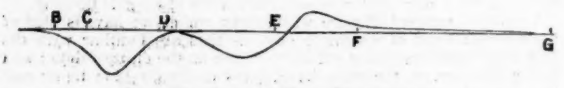


Fig. 15.—Arc and Sun—Difference.

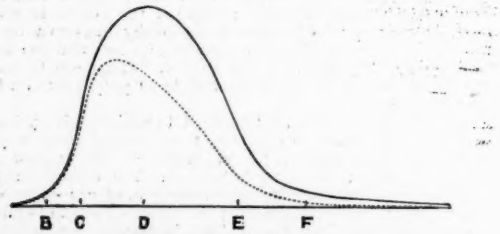


Fig 16.—Arc and Gas.

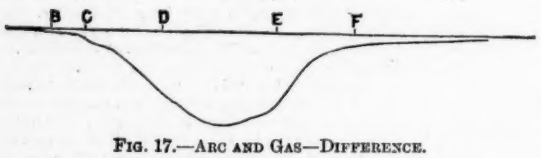


Fig. 17.—Arc and Gas—Difference.

Assuming ideal daylight to be rather less yellow—that is, more blue than sunlight—the dotted curves in fig. 18 have been drawn from Captain Abney's curves of sunlight and the light of blue sky. One-third of the difference between sunlight and blue sky has been added to the sunlight. The dotted curves are of the same kind, but the ordinates have been reduced. Fig. 19 shows the differences. Compared with the strongest daylight curve, the arc has a marked excess of orange, and deficiency of greenish blue. With weaker daylight there is a greater excess of yellow; and with the weakest light shown, since it lies almost entirely within the arc curve, there is practically no deficiency in the blue.

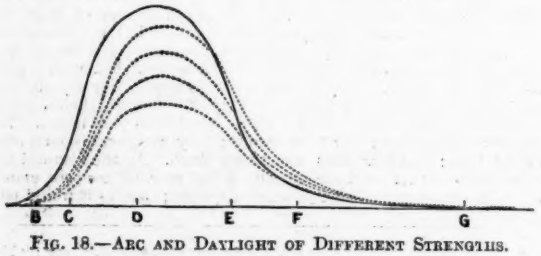


Fig. 18.—Arc and Daylight of Different Strengths.

There are two different ways in which this result may be practically used to produce artificial daylight. A glass or other medium may be tinted with stains, or dyes, which will absorb the proper amount of yellow and red light, and the lamp may be surrounded by such a medium; or a reflecting screen may be painted with such a colour that this yellow light may be absorbed, and the white light alone may be reflected. Blue glass chimneys are used for microscope work, and are occasionally used for reading lamps with the view of giving a more agreeable light. The lowest curve but one in fig. 19 has a small deficiency of greenish blue: this would affect the eye as a very faint yellowish tinge. If the excess of yellow in the rest of the spectrum could be corrected, a very close approximation to daylight would be attained. About one-third of the useful power of the light would have to be sacrificed. With gaslight or glow lamps more than two-thirds of the light would have to be absorbed in order to reproduce the effect of daylight.

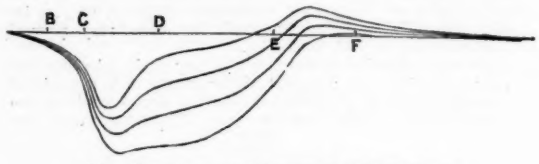


Fig. 19.—Arc and Daylight—Differences.

Quite apart from considerations of colour-matching, the use of a white light ought to be good for the eyes, since all the nervous elements would be equally excited as in normal daylight. The author has not yet completed his experiments on coloured shades, but has produced colour screens which, when illuminated by lamplight, reflect a light which cannot be distinguished from white when compared with daylight. It does not follow that the light is identical with daylight; but he hopes to follow up the matter during the summer.

Discussion.

The President: Before commencing the discussion, I will ask those of you who have any questions to put to Mr. Trotter for purposes of elucidation or explanation of any difficulty, to put them now. Mr. Trotter's paper appears to be so clear that there are no difficulties.

Mr. Swinburne congratulated the author very heartily on his paper, which was evidently the outcome of a great deal of experimental work. The statement, due in the first place to Prof. S. P. Thompson, that the arc was necessarily at the temperature of volatilising carbon gave us the means of constructing an electrical standard of light. What is wanted is a standard which is definite as to quantity and as to colour. Kirchhoff has shown that all incandescent bodies gave out light of the same colour, that is to say, having the same proportion of lights of different refrangibility. The amount of light given by each square inch at a given temperature depends on the emissivity. It is hardly likely that the emissivities of different kinds of arc carbon vary perceptibly. To get a standard, the image of the arc is thrown on a screen by a lens, or preferably by a shade with a pinhole of known size. The image is thrown on the screen, the image of the crater being uniformly illuminated at a standard illumination of a standard colour. A second hole, also of fixed area, is arranged in the middle of the image of the arc. Through this hole the standard quantity of light of the standard colour is transmitted. As Mr. Trotter points out, the colour of the arc light is practically that of daylight, and is thus the best for a standard. The quantity of light of any particular colour is thus also standardised. It was much to be regretted that Mr. Trotter had not given more information about arc lamps with alternating currents. With the same power it was to be expected that an alternating arc should give less light, as these were two small craters instead of one large one. In addition one crater was on the wrong carbon. An ordinary alternating lamp also ran with less power, the pressure being lower. On the other hand, an alternating arc lamp was much easier to deal with, as an inductive circuit can be used to secure a steady light instead of a wasteful resistance. He would like to hear the opinions of those who have had much experience of alternating arc lamps. He had tried passing a stream of gas through a hollow carbon, in 1884 or 1885, but it did not increase the light at all, it merely caused unsteadiness, or blew the arc out.

Major-General Festing, R.E.: Having studied the subject of colour of light a little in conjunction with Captain Abney, I should like to confirm what Mr. Trotter has said as to the light from the electric arc lamp being really white. I suppose it has occurred to most people at some time or other to test arc lamps by daylight. I have had arcs running in the Museum underneath the skylights, where, of course, they were in direct competition with the diffused light coming through the skylights. To me the arc light was distinctly yellower than the diffused light—yellower, but not to any great extent. How much the globe has to do with it I do not know; it is a point I have not taken the trouble to work out. I daresay many of us have stayed up dancing until the small hours of the morning, and by that time our sense of yellow light has become rather wearied. You cannot fail to remark at such a time, when you open the window shutter, that the light which comes in appears quite as ghastly as ever the electric light does. If you get up at four in the morning it does not strike you that the morning light is ghastly at all. A reference

to the diagram from Captain Abney's book shows that there is practically no difference between bright sunlight and the light of the electric arc. Sunlight, of course, as we all know, varies a great deal. It is very different in London from what it is in the country. The only standard we can fix of white light, it seems to me, is what we are accustomed to in daylight. People have said if we were to live outside our own atmosphere the sunlight would be blue. That is all moonshine. Our idea of white light is the integration of the whole light we get from the sun and sky, particularly from the sky. When the sun gets at all low it gets gradually yellow, and in London, as we know, very often something worse than yellow. I think the statement about blue being absorbed in the atmosphere requires correction. It is not a case of absolute absorption, but a case of scattering; the blue rays get scattered according to the law established by Lord Rayleigh, and that is why the sky to us is blue. The light passing has been sifted by the air; the blue rays are scattered and come down to us in the form of blue light from the sky. A remarkable illustration of that occurred to us one winter afternoon. A photographic plate was exposed with the (red) sun focussed on it, yet it left no trace, although trees and houses were properly represented, these having been illuminated by the blue rays scattered out of the sun's beams passing overhead. As I said before, no absolute standard of whiteness of light can be laid down. What we are accustomed to live in at the time is what we call white light.

Dr. SUMPNER: Mr. Trotter has brought before us a great number of interesting points. Perhaps one of the best is that by means of which he explains the shape of the characteristic curve of the arc light. He practically proves that its form is due to the fact that the incandescent surface of the carbon gives out light in any direction proportional to the apparent area of the surface seen from that direction. He practically proves it by what he says, but there is something which has occurred to me which confirms it. There is a formula which I think was first published at the Paris Exhibition in 1881, a formula for finding the mean spherical candle-power of an arc lamp from the measurement of the horizontal candle-power and the maximum candle-power. The formula is this—that the mean spherical candle-power is equal to half the horizontal candle-power plus a quarter of the maximum candle-power. The mean spherical candle-power of an arc lamp is not perhaps of great importance, but it is a quantity which has a very definite meaning, and if we try to explain its value as given by this formula, we come naturally to the explanation Mr. Trotter has brought forward. This formula can be explained by assuming that the characteristic curve is made up of two parts, the first part being a circle of the diameter equal to H, this point [indicating] at the end of the horizontal diameter being the radiant point of the light, and the diameter representing the horizontal intensity of the candle-power; and the other part of the curve being composed, as Mr. Trotter suggested, of a semi-circle cut off by the shadow cast by the lower carbon. Then supposing the resultant characteristic curve is made up of a curve such that its radius vector is equal to the sum of the two radii of these two curves, you get a curve very like that which Mr. Trotter has sketched. The mean spherical candle-power of that curve will come out to be half the horizontal intensity plus the quarter of the maximum intensity. The first of these two quantities is due to the circle of diameter, H, and the second and more important is due to the semi-circle cut off by the shadow as Mr. Trotter has explained. The physical meaning of that seems to be that the light is due to two causes. One part is due to the carbon stick being more or less incandesced round the surface, due to the heating of the carbon, and the other part is due to the bright discs at the ends of the carbon rods. The two incandescent discs would throw out a curve of that shape, as Mr. Trotter has said, and the cylindrical surfaces of the carbon would throw out light in a way regulated by the circle. This formula, published ten years ago, I have proved by my own measurements and actual calculations to be correct within four or five per cent., or as nearly correct as you can expect photometric measurements to be, remembering that the light of an arc lamp is not a steady thing. The physical meaning of that formula, then, is that the light is due in the first place, as Mr. Trotter suggested, to the light given out from the top carbon considered as an incandescent disc; and, secondly, a much smaller part is due to the heating of the carbon rod, which causes the cylindrical surface of the carbon to be more or less incandesced.

The PRESIDENT: Mr. Swinburne has referred to alternating current arc lamps. It is an important question whether they do cause so much trouble as not to be worth using. Perhaps somebody would like to speak on that subject.

Mr. W. M. MORDEY: I have not had the opportunity of studying the paper beforehand, but I think Mr. Trotter has given us a very carefully considered paper and that he has given the true explanation of what Dr. Sumpner has called the characteristic of the arc, and has thrown a good deal of light on the subject. I should like to question Mr. Trotter on one or two points where my experience does not quite agree with his. He states that a good arc has a uniform horizontal crater. One arc, of course, is as good as another; it is simply a matter of current and carbon. With the same carbon you have the same arc. I am not speaking now of the regulation of the arc. I have never come across a uniform horizontal crater; but have always found craters of arcs, where the carbons were not out of proportion to the current, quite concave. I hope Mr. Trotter will explain what he means by the goodness of the arc to give the horizontal effect. No doubt the horizontal effect is better than a concave crater if you can get it: but I do not know how to get rid of the concavity except by a flaming arc. Then, further on, it is stated that in the case of cored carbons, the cored part is less brilliant than the rest of the crater, and I gather that Mr. Trotter intended us to understand that the core was made of something other than carbon. I believe many makers now use in the cores certain substances not carbon; but a good many carbons are made with simply soft graphite for cores, and in such carbons the arc is steadied, but there is no difference in the density, in the colour, in the degree of light over the crater. No doubt with impure cores, made with foreign matter the core would be cooler. With regard to alternate current arcs, I should have been very glad if Mr. Siemens had spoken—I shall be very glad if he is going to speak in the discussion—because I think he has had greater experience with large alternate current arcs than any of us. At the Naval Exhibition we all admired the very large arc run on the lighthouse, which was visible over the whole of London. That was an alternate current arc, and seemed to burn very steadily whenever I saw it; it certainly was steadier than any direct current arc of equal power I have ever seen. We know how difficult it is to run a direct current arc without a large steadying resistance in the circuit; and, by the way, was not the function of that resistance first pointed out by Mr. Siemens at the Society of Arts, about nine years ago? I entirely disagree with the author of the paper as to alternate current arcs not being worth using, and as to their giving trouble. I am perfectly indifferent, commercially, whether people use direct current or alternating current arcs, but I must say I have got better results with alternating current than with direct, and I put it down to the fact, first, that you can use longer arcs with the same E.M.F., and the small difference of length due to the feed does not affect the whole result of the arc as with the short direct current arc; and secondly, to the fact that the alternating current causes a slight vibration in the mechanism of the lamp, and that assists the feeding of the carbon. Of course I recognise that this paper deals with scientific questions and not with such questions as the mechanism of arc lamps, but I think Mr. Trotter will find that with any ordinary arc lamps, if skilfully made for alternate current working, those two causes will enable him to get better results for the same type of lamp with alternate currents than with direct currents. Then we are told "A large alternate-current arc is very unsteady. The flame burns away the carbon in a very irregular manner; and when round carbons were used a hollow crater was formed at the end of each." That may be the case, but I am sure Mr. Siemens can set that at rest by telling us how the big arc burnt at the Exhibition. My company will, in the course of a day or two, have running a very large alternate current lamp at the Crystal Palace Exhibition; it will take 200 ampères and be automatically fed. You will have an opportunity of seeing whether that lamp can be made as steady as the ordinary search light arc of equal power; I think you will find it steadier. We will also have hung up in the Palace an ordinary alternating arc, run in the ordinary way, so that anybody may see whether the arc is steady and whether it justifies its existence. It shall be put in a dark lantern, so that you may study the arc itself. There is a reference in the paper that I do not quite understand as to whether an arc can change its temperature during half a period of the generation of an alternating current. Well, that is a physical matter that I am not competent to give any opinion upon, but I should think that with any ordinary rate of change of alternating currents, anything from 40 to 150, such as we have in practice, the mass of the carbon would be too great to allow of any visible fluctuation in temperature. It must surely act as a kind of thermal fly-wheel and have a fixed mean temperature during the whole period. I quite agree with Mr. Trotter's criticism of the lighthouse arc lamp shown in the wall diagram; I think that is a very bad arc indeed. The arc is far too short; the light cannot get out; it will not burn steadily. I suppose it would not burn with the modern machines at all, unless it had something like 30 per cent. of the total fall between the dynamo terminals in the resistance, and if it is possible to burn with such a very short arc, I suppose it is on account of the large drop in the curve of the dynamo. I think there should be a length of clear arc at least one-quarter of the diameter of the carbons to get good results. We are told the South Foreland experiments showed that a short arc gave more light than a long one. I think that statement ought to contain some reference to the energy absorbed in the arc. A short arc with the same terminals and, of course, a lower E.M.F., a lower difference of potential on account of its shortness than a long one, I think would be found to give less light than a long arc; and does not Mr. Trotter's characteristic show us that we ought to have long arcs, that we ought to let the light get out? I would suggest that it might be possible to get a better illumination curve from the arc lamp, and for many purposes an improved result by putting one of the carbons horizontally and the other vertically, and forcing out the arc by means of an electro-magnet, so as to get the whole surface exposed and throw light down. Something of the kind has been proposed to a limited extent, I believe, for search lights, to deflect the light a little to one side in order to get it into the reflector. It is unfortunate that Dr. Hopkinson is not here to tell us of the result of experiments in introducing volatile substances into the hollow carbon. At one time we were led to expect some improvement in that direction, but we are still going on in the old fashion. Now, Mr. President, if my memory is not at fault, I feel that I may appeal to you to justify the custom of the trade in calling the 10-ampere 50-volt lamp a 2,000 C.P. lamp. At the last Crystal Palace Exhibition, I think in 1882, or perhaps it was at the Paris Exhibition the year before, you and others made some photometric measurements of the Brush arc lamp, and brought it out at 2,300 C.P. I am speaking from memory, but I think those were the figures. The old practice in America, followed at one time by one of the large companies, the Weston Company, and seen in the original lighting of Queen Victoria Street here, of using very short arcs, has not been followed of late years; it was claimed that they were better, steadier, and more efficient than the long arcs; but my experience does not confirm that. There was a very interesting arc lamp, both mechanically and in a physical way, that Mr. Trotter has not mentioned. I refer to the Varley lamp at the Inventions Exhibition, in which a carbonised rope was used. The carbon was a piece of charred rope, coiled upon a drum, I believe

and fed out at a very slow rate by some kind of mechanism gearing with the rope; the arc was of an enormous length, something like an inch or an inch and a quarter with 20 volts. I have not heard of that since the exhibition. I should like to know if Mr. Trotter has tried experiments with lamps in air-tight globes. I once made some tests, the idea being to get rid of the rapid consumption of carbon; and the consumption of carbon in an air-tight globe is very much less than in the air, and as far as one can see the lamp burns just as well. It shows, of course, what the effect of combustion is. As soon as you get the oxygen out of the air the carbon is not burnt, and the arc takes place in an atmosphere of carbonic oxide and nitrogen. It, however, blackens the globe a good deal, the carbon being thrown down on the globe.

The PRESIDENT: Possibly by the next meeting, which will be on May 12th, the current may be laid on, and Mr. Trotter will then be able to show his experiments. Probably, also, by that time, some other speakers would like to contribute to the discussion. Under those circumstances, I think the best thing to do is to adjourn the discussion on Mr. Trotter's paper till the next meeting, when probably we shall have time also to take one of the other papers promised to be read during the remainder of the session. I have to announce that the two members, eleven associates and five students balloted for this evening have been elected.

The meeting then adjourned.

THE LIVING DYNAMO.*

BY OLIVER WENDELL HOLMES.

(In honour of the 70th birthday of Edward Everett Hale.)

Night after night the incandescent arc
Has fought its dazzling battle with the dark,
Our doubtful paths with purest ray illumed,
Untired, undimmed, unswerving, unconsumed.

A slender wire the living light conveys
That startles midnight with its noonday blaze.
Through that same channel streams the giant force
That whirls the wheels along their clanking course
When, like a mail-clad monster, o'er the plain,
With clash and clamour sweeps the broomstick train.

Whence gains the wondrous wire its two-fold dower,
Its double heritage of light and power?
Ask of the motor-man—he ought to know—
And he will tell you "from the dynamo."
And what, again, the dynamo inspires?
"A mighty engine, urged by quickening fires."

When I behold that large untiring brain
Which seventy winters have assailed in vain
Toiling, still toiling at its endless task,
With patience such as Sisyphus might ask,
To flood the paths of ignorance with light,
To speed the progress of the struggling right,
Its burning pulses borrowed from a heart
That claims in every grief a brother's part,
My lips repeat with reverence "Even so—
This is in truth a living Dynamo!"

Be ours to heed its lessons while we may,
Look up for light to guide our devious way—
Look forward bravely, look not weakly back,
The past is done with, mind the coming track;
Look in with searching eye and courage stout,
But when temptation comes look out! Look out!

Heaven grant all blessings time and earth can give
To him whose life has taught us how to live
Till on the golden dial of the spheres
The twentieth century counts its gathering years,
While many a birthday tells its cheerful tale,
And the round hundreth shouts, All hail! All hail!

* New York *Electrical World*.

NEW PATENTS—1892.

7,803. "Improvements in or appertaining to high tension constant current dynamo-electric machines." T. R. ANDREWS and T. PREECE. Dated April 26th.

7,826. "Improvements in electric lamp shades as a medium for advertising." T. FROGGATT. Dated April 26th.

7,833. "An electrical metronome or time beater or regulator for musical and other purposes." J. WALKER and J. HAMPSHIRE. Dated April 26th. (*Complete.*)

7,855. "Electric switches." C. E. CHALLIS. Dated April 26th.

7,858. "Improvements in the construction and insulation of electrical contact devices and like apparatus." M. BINSWANGER. Dated April 26th.

7,915. "Improvements in electric switches." A. W. ISENTHAL. Dated April 27th.

7,935. "Improvements in telephones." D. MARR. Dated April 27th.

7,961. "An improved electric circuit-closer." G. W. PRICE. Dated April 27th.

8,046. "Improvements in electrical measuring instruments of the Cardew type." H. C. L. HOLDEN, B. M. DRAKE and J. M. GORHAM. Dated April 28th.

8,062. "An improved machine for giving electric shocks automatically by the insertion of a coin." G. BRYANT. Dated April 28th.

8,064. "An improvement connected with thread-coating of electric wires." W. A. G. BIRKIN. Dated April 28th.

8,083. "A means of electrically heating iron, steel, and other metals in the processes of rolling, drawing, pressing and stamping." J. O. DALE. Dated April 29th.

8,090. "Improvements in the production and regulation of electric currents for lighting and other purposes and in apparatus connected therewith." J. W. WIGNALL, W. HIRST and J. SMITH. Dated April 29th.

8,108. "Improvements in the manufacture of metallic articles by electro-deposition." J. W. DAVIS and J. O. EVANS. Dated April 29th.

8,115. "Improvements in and relating to posts or standards for carrying electric lights, wires, and the like." J. B. MILLAR. Dated April 29th.

8,127. "Improvements in electric telegraphs." S. EVERSHED. Dated April 29th.

8,165. "Improvements in electric meters." F. V. ANDERSEN. Dated April 30th.

8,196. "Improvements in arc light poles or masts." B. DEAKIN and W. L. SPENCE. Dated April 30th.

8,211. "Improved means for stopping or controlling electrical railway and tramway engines or carriages." M. H. SMITH and T. P. WILSON. Dated April 30th.

8,212. "Improved means of holding and supporting electric conductors or otherwise, ropes or bars." M. H. SMITH and T. P. WILSON. Dated April 30th.

8,213. "Improvements in coupling electric conductors and like wires." M. H. SMITH and T. P. WILSON. Dated April 30th.

8,222. "Improvements in dynamo-electric machines and motors." W. C. RECHNIEWSKI. Dated April 30th. [Date applied for under Patents Act, 1883, Sec. 103, October 31st, 1891, being date of application in France.]

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,034. "An improved device for facilitating the connection and disconnection of electrical conductors." A. L. SHEPARD. Dated May 9th. Relates to a device in which the circuit can be interrupted without completely withdrawing the plug, and in which the risk of short circuiting is obviated. 5 claims.

8,136. "Improvements in electric car motors." J. CHRISTIANSEN. Dated May 12th. The objects of the improvements are: first, to place the electric motor inside of the car, where it is readily accessible and protected from grit and dust; second, to arrange for a continuous running armature, the motion of which can at will be quickly communicated to the axles of the car, and as quickly again released; third, to avoid the employment of special and expensive motor-trucks for the attachment of the electric motor; fourth, to reduce first cost and wear and tear, and the consequent expense of repairs to the driving mechanism. 9 claims.

8,163. "Improvements in electric railways." M. W. DEWEY. Dated May 12th. Consists broadly in an electric railway having a portion thereof equipped with a conduction system and another portion equipped with an induction system. 18 claims.

8,932. "Improvements in electric locomotives or street car motors." H. H. LAKE. (Communicated from abroad by R. Eickemeyer, of New York.) Dated May 26th. Relates to the adoption in electric locomotives of direct pitmen or link connecting gear. 9 claims.

8,941. "Improvements in method and apparatus for electrical hardening and tempering." A. J. BOULT. (A communication from E. E. Ries, of Baltimore.) Dated May 26th. In the improved process the article to be hardened is heated very rapidly by the passage through the same of a suitable current of electricity, which will raise the same to a certain accurately adjustable degree of incandescence, and will maintain it in that condition until the instant of immersion into the chilling bath. 38 claims.

9,029. "Improvements in electric arc lamps." W. A. TURBAYNE. Dated May 28th. Relates to electric arc lamps, the object being to provide the simplest means possible for striking the arc and regulating the feed of the upper carbon. 5 claims.

9,241. "Improvements in or appertaining to electric railways." W. P. THOMPSON. (A communication from abroad by C. K. Harding, of America.) Dated June 1st. Relates more particularly to underground conductors for electric railways, and to the manner of operating the circuit between the same, and the devices upon the car which are to be operated thereby. 11 claims.

9,435. "An electrical transformer." E. F. H. H. LAUCKERT. Dated June 3rd. Claim:—An electrical transformer wherein pieces of thin sheet iron, each of approximately U-shape with one limb longer than the other, are grouped together, overlapping each other in such a way as to form two lateral cores, and a middle core con-

sisting of twice as many thicknesses as the lateral cores, one, two, or three of these cores being enclosed in bobbins and magnetically connected by iron strips, substantially as described.

9,462. "An improved electrostatic switch and indicator for alternating current circuits." A. U. ALCOCK. Dated June 4th. Is mainly for the purpose of placing alternating dynamo machines into parallel circuit, and, secondarily, for the purpose of indicating when the line currents or machines are in "phase" or synchronism. 5 claims.

9,522. "Improvements in alternating current electro-magnetic motors." W. STANLEY, Jun., and J. F. KELLY. Dated June 4th. Consists in the combination with a motor of a condenser in series with one or both of its circuits, which condenser has sufficient capacity or value, according to the conditions of the circuit, to neutralise or overcome the self-induction of the same. 3 claims.

9,524. "Improvements in methods of and apparatus for preventing the interference with speech on telephone circuits by induced and other currents." W. STANLEY, Jun., and J. F. KELLY. Dated June 4th. The inventors interpose in the circuit, between the receiving phone and the line, a self-induction coil and a condenser, to which such values are given that they will operate to hinder to the greatest possible extent the propagation of current waves of a frequency below a certain predetermined limit, but permit the speech-producing currents, which are of much higher frequency, to pass without material opposition. 5 claims.

9,627. "Improvements in thermo-electric batteries." C. D. ABEL. (Communicated from abroad by R. J. Gülcher and the firm of J. Pintsch, both of Berlin.) Dated June 6th. Consists in reducing the internal resistance of the separate rows of thermo-electric elements arranged round a heating chamber, or themselves forming such heating chamber, in the same proportion as the electromotive force decreases with the temperature in those parts of the heating chamber where the elements are more and more distant from the source of heat. 2 claims.

9,762. "Improvements in secondary or storage batteries." S. C. C. CURRIE. Dated June 9th. In the present invention the principal object is to convert or transform ordinary lead cast or rolled partially into a porous or soft spongy metallic state or condition by electrolysis for use as a battery element.

9,928. "Improvements in galvanic batteries." G. A. SCHOTH. Dated June 11th. Relates specially to dry batteries, and consists in the use of dried compressed moss, generally known as "sphagnum," for containing or immobilising the exciting liquid. 3 claims.

10,227. "Improved electrical conductor." P. H. HOLMES. Dated June 16th. The arc-light pencil is made essentially of plumbago in a finely divided state, which is moulded into the desired form by pressure and then treated with some binding material, such as a drying oil, for instance, which will make the particles of plumbago adhere to one another, and in order to produce a pencil which will withstand the more or less rough usage to which it is subjected, the inventor mixes with the plumbago sufficient finely divided fibre, such as, for example, divided wood fibre, to give it the desired strength. In making a commutator brush he uses a compound of plumbago and fibre bound together by a suitable binder, preferably drying oil. 5 claims.

10,695. "An improved method of and apparatus for heating metal bars or blanks by electricity for forging and other purposes." E. E. ANGELL. Dated June 23rd. Consists in the method of heating metallic bars or blanks by inserting a bar or blank in an electric circuit, then inserting another bar or blank in shunt in the same circuit, and then withdrawing one of said bars or blanks from said circuit, the other bar or blank remaining in circuit during such withdrawal 11 claims.

10,697. "An improved method of and apparatus for protecting dynamo-electric generators and other apparatus from the effects of lightning." H. H. LAKE. (Communicated from abroad by the Thomson-Houston International Electric Company, of America.) Dated June 23rd. Consists, briefly, in causing the lightning discharge, when passing to earth, to generate by induction a counter-electromotive force opposing the passage of the discharge through the generator, or other apparatus to be protected, and thus effectually prevent injury thereto. 5 claims.

11,118. "Improvements in electrical signals for steam vessels and analogous purposes." A. M. CLARK. (A communication from abroad by E. W. Tucker, of California, and L. Katzenstein, of New York.) Dated June 30th. Consists in the combination, with an electric alarm, of two or more electric indicators or combined indicators and levers, one of which is located in the pilot house, and others in as many different parts of the vessel as may be deemed necessary, each of which is properly connected to the one located in the engine room, so that when the pilot moves his lever indicator, communication will simultaneously be had with the engine room, and serve to set the alarm in motion for the purpose of notifying or calling the engineer's attention, and, at the same time, move the arrows attached to the dials, in order to show the direction the engine is to go, and at what speed. 16 claims.

11,145. "Improvements in and connected with printing telegraph instruments." D. H. BATES and H. VAN HOEVENBERGH. Dated June 30th. The object of the invention is to provide means whereby two or more copies of a message may be simultaneously printed by a single instrument, the duplicate messages being printed side by side upon two ribbons of paper or upon a single ribbon of paper, so prepared that the two copies of the message may readily be separated from each other. Two type wheels are employed. 2 claims.

CORRESPONDENCE.

The Board of Trade Unit.

The Board of Trade has kindly wished to adopt the name "kelvin" for the "Board of Trade unit," and had taken the necessary preliminary steps for introducing it into the Provisional Order for this year. But I have pointed out some reasons why this should not be done; and I am permitted to say that the Provisional Order will not introduce any new name.

It seems to me that the difficulty which has been felt in the cumbrousness of the name "Board of Trade unit" will be obviated wholly and in the most simple manner by using "supply-unit" to denote the particular unit defined by the Board of Trade for the reckoning of electric supply. Thus, supply meters, by whomsoever invented, will give their readings in supply units. Ordinary householders, who know nothing of ergs, of meg-ergs, of joules (though knowing the name and something of the work of Joule), of watt-hours, (though all know James Watt), will naturally use the simple word "unit" in checking and paying their electric lighting accounts. In scientific statements the double word "supply unit," with only four more letters than "kelvin" will perfectly distinguish the particular unit intended from all others.

Kelvin.

May 6th.

The Illumination of Vacuum Tubes by High Potential and High Frequencies.

Mr. Tesla's experiments have set many of our "leading lights" experimenting in the same direction. Prof. Crookes has by similar means repeated and added to the phenomena exhibited to us by Mr. Tesla. I had the pleasure of initiating a meeting with Mr. Crookes, with some of his tubes, and Mr. Wimshurst, with his large influence machine, to try some experiments I had long wished to do, and the same results were obtained as by Mr. Tesla's system, though with not quite the same brilliancy. I find a small Wimshurst machine will also give the same results. Messrs. Siemens and Messrs. Swinburne & Co. have also followed in the wake and have shown some very instructive experiments.

I think it may be interesting to many to learn that in Joseph Priestley's work entitled "The History and Present State of Electricity, with original Experiments" (1775), he recounts the experiments of the early scientists with electricity, and in writing of Mr. Hawksbee (1709) who, he states, "was indefatigable in making experiments, and there are few persons to whom we are more indebted for a real advancement of this branch of knowledge, that, holding an exhausted globe within the effluvia of an excited one, he observed a light in the exhausted globe which presently died away if it was kept at rest, but which was revived and continued very strong if the exhausted globe was kept in motion," and there is also recorded a series of other similar experiments, all very curious and interesting.

In bringing this forward, I do not in the least wish it to be thought that I do so to detract one iota from the merits of, and the interesting work lately done by, the gentleman I have named, I merely do so to show what I have unearthed as having been known and done in this branch of our science nearly 200 years ago.

C. E. Spagnoletti.

May 7th, 1892.

Telephone Exchanges.

Many thanks for the insertion of my proposed exchange system. You state in your footnote: "Before calling subscribers could be cut off the operator would have to answer." I don't think this is a drawback. With regard to your suggestion of having the operator's phone in circuit, I provided for such, but perhaps omitted it in my explanation. When switch is on right side, this is done. I placed the indicator in circuit, so that if the operator was not at that moment listening her attention might be called. My drawing only gave one pair of plugs as the others would be connected up same way (10 to each 100 subscribers). The falling of the clearing out drop and derived circuit to operator's phone is not essentially a part of the system; only I thought it would be a good way to compel the operator to attend. Very rarely is there more than two drops down at one time, and the very fact of them being thrown on

"public wire" would compel her to put them up or disconnect as the case may be. Should this explain things a little more, would you kindly insert it. My only object is to give "the best telephone service possible."

Peter K. Higgins.

Santiago, *March 24th*, 1892.

Recording Measuring Instruments.

Your engraving and description of a recording pressure and current instrument at page 583, leads me to offer to your notice the enclosed record paper from a combined instrument of this character, which was made to my design two years since by Messrs. Richard Frères.

Their recording voltmeters and ammeters are similar in action to their well known recording barometers, &c., and the only novelty in this case is, that I had the two instruments placed one over the other, reading on the same drum. The latter is about 9½ inches in diameter and 11 inches high; the paper which it receives is divided into spaces of 2 hours each by arcs of circles about $\frac{5}{16}$ths inch apart, whose radius of about 11 inches corresponds with the length of the usual long and delicate lever, with its pen for aniline ink.

The voltmeter is permanently connected with the secondary battery of 25 cells. The ammeter is interposed in the discharging circuit. Therefore, as the hour lines for both instruments are continuous (the length of the two levers being identical) the condition of the battery at all times is faithfully recorded, as well as its behaviour in relation to any period of discharge.

It is interesting to notice the slight fall of E.M.F., seldom more than one volt, when 30 or 40 ampères are passing out, and the recovery of pressure as the discharge ceases. Taken separately—the upper curve shows the amount of discharge at any time during the week—between 6 and 8 a.m. and 4 and 12 p.m. are the times of lighting for this particular example; while the lower curve shows also, the time when charging was commenced, how long it lasted, and whether the full charge was given—of which the maximum of 62·5 volts is an unfailing indication. The break in the charging curve shows when the dynamo was not working—the dinner hour in fact.

The resistance of the voltmeter is slightly over 11,000 ohms. The horizontal lines were ruled to correspond with points determined by comparison with standard instruments. The ammeter is sensitive to two lamps, but not to one. The friction between pen and paper is very trifling.

Thomas S. Bazley.

Cost of Electricity.

I had the honour of being noticed by you recently regarding a discussion which appeared in the pages of your lively young contemporary, *Lightning*, on the question of the true financial comparison between the cost of electricity and gas, light for light.

Mr. Gaine, the Town Clerk of Blackburn, does not appear to read your columns, or he would have been met, not by statements only, but by actual figures taken from practice, which showed that for situations where gas could be obtained yielding a luminosity of 15 to 16 candle-power per 5 cubic feet per hour, the factor by which to multiply the cost per unit to obtain proportionate cost of gas per thousand is 12. When this figure is used, the simple rule—first stated, I believe, by Mr. Raworth, of the Brush Company—that the cost per unit in pence equals the cost per 1,000 in shillings, comes into play.

I do not pretend to say that 100 cubic feet of gas and one unit (or Kelvin) do not in some place equate in illuminating power, but I do say, and that without fear of disproof, that for Liverpool, and other large cities, the REVIEW is right in taking 12 as the multiplying factor. Mr. Holmes, of the Liverpool Electric Supply Company, Limited, I think, takes 10 as his ratio for places outside Liverpool, and no doubt, for situations such as he was speaking of when using this figure, he gave a fair comparison, but the question was one which was decided for municipal purposes about a year ago, by a joint consideration on the part of the City Engineer, Gas Inspector, and myself, and the City Fathers have adopted the 12 as representing the ratio for the district under their sway.

The great mistake made by most people in dealing with this question is the desire to reason without stating the data on which such reasoning is to be based. Gas of 20 C.P. per 5 feet per hour will give a different ratio to gas of 15 or 12 C.P. per same burning rate.

It is unnecessary here to repeat my figures published in February, 1892, but I shall be glad to go over any other figures which may be published, and either disprove them, or accept such for future work.

When on this question I should like to enter my protest against the feeling of the REVIEW in criticising the accuracy of C.P. tests taken by the London County Council. To anyone acquainted with photometric work and the care bestowed on accuracy, I think it will appear unjust to put forward such suggestions as those referred to and directed against the expert gas testers of the London County Council. They are on a par with Mr. Thomas Parker's remarks as to electric inspectors before the Electrical Standards Committee of the Board of Trade, which for bias and ill-feeling against a rapidly rising class of men have been unequalled for some time. Taking London County, Bath, Birmingham and Liverpool, one needs only to meet the men who have been chosen for their ability and past record, to go over the laboratories of the municipal bodies with them, and to a trained mind all doubt as to the trustworthiness of their results vanishes, as in few departments of municipal life is such care taken to protect both the interests of the supply company and those of the municipality as in the newly created electric branch.

In closing this somewhat rambling note, I should like to suggest to your friends who are so much down on the "threadbare theory" that figures in support of their contention would be acceptable, and convey conviction to some people's minds quicker than the use of such words as "pique" "fallacy," &c.

Charles W. Yeaman.

May 9th, 1892. *Late City Electrical Engineer, Liverpool.*

Armature Heating.

On my return from abroad I read the criticism of my article on "The Radiation of Heat by the Armatures of Dynamo-Electric Machines," in your number for April 8th. Kindly allow me to answer it in a few words.

I agree with you when you say that, generally speaking, Foucault (eddy) currents must be taken into account in calculating the heat developed in an armature, but this remark hardly applies to my paper. In fact, trials of the efficiency of my machines have shown me that the Foucault currents were not of importance; this is due to the fact that the sheets of iron in the armatures are sufficiently thin for the lines of force to follow the lines of the sheets, and not to the fact that the copper wires are protected by the teeth against the Foucault currents. Very careful trials of efficiency made by coupling two similar machines axle to axle, and making one act as motor and the other as generator, have shown me that the internal losses may be calculated with sufficient exactness without taking into account Foucault currents.

These trials of efficiency have been made with nearly all the machines mentioned in my paper.

It is certain that in many other machines we should have to reckon differently.

But please consider that the object of my paper was not to find a method which would enable us to calculate, in a general manner, the quantity of energy transformed into heat in an armature; but, taking some armatures very different in form, for which I knew the quantity of energy transformed into heat, to see how much heat was radiated from each square centimetre of surface for a given difference of temperature from the surrounding atmosphere. I know very well that Messrs. Kapp, Esson and others have given certain formulæ for calculating the cooling surface; but no one has shown in what ratio the coefficients of these formulæ should vary with the form of the armature, and no one has shown that these coefficients may vary from single to double, by indicating, by means of a sketch, the form and dimensions of the armature to which they relate.

On referring to my results, it will be seen that it is impossible to represent by a single formula the radiations of heat from the surface of armatures, and that the coefficients of such a formula must change in considerable proportions with the form and dimensions of the radiating surface.

The object of my article was simply to draw the attention of constructors to this point.

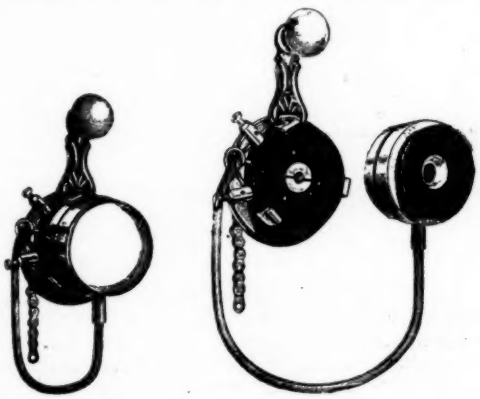
M. Rechniewski.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

Domestic Telephones.

IT was generally anticipated by the public that the expiration of the Bell and Edison patents would be immediately followed by free trade in telephones in this country, and that the use of the instruments as a means of communication would at once receive a considerable impetus. The lapse of Edison's patent freed carbon as a material, but manufacturers are deterred from undertaking the construction of any of the various forms of transmitter in general use, owing to the existence of subsidiary patents, such as Crossley's, which protects the pencil form of microphone when more than two pencils are employed, Hunnings', which protects microphones of the granulated carbon type, and Blake's. Without the necessary auxiliary of an efficient microphone transmitter, the application of the telephone can be but limited, hence such extension of its use, as is in evidence at the Crystal Palace, is largely confined to domestic application.

Of telephonic apparatus there is an abundant supply on show at the various stalls, and the general visitor will find much that is interesting, but from the professional point of



"ON" FIG. 1. "OFF"

view the display is disappointing. Indeed, there is a general concensus of opinion expressed by the exhibitors themselves, that there is very little on show that is new. Such improvements as are noticeable are principally in matters of detail,

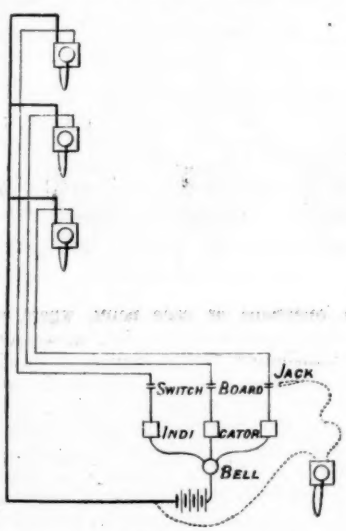


FIG. 3.

and there is little to be seen that has not been described prior to the opening of the Exhibition.

A novel arrangement, intended to combine the new order of things with the old, is to be seen at the stall of Messrs. Anders, Elliott, and Cheetham-Strode, Limited, where a watch-shaped single-pole Ader receiver is shown combined with the old-fashioned bell crank. The rosette is removed from the latter, and an ebonite attachment is substituted, with clips for supporting the telephone, on the back of which the rosette is fixed. A twin wire is run to the various points throughout the house, and connected to the telephones, and a receiver is provided in the kitchen. The ordinary bell is retained for calling. In large domestic establishments the arrangement will, no doubt, find favour as a means of saving both time and labour. It possesses the merit of simplicity and cheapness, and there are no batteries required, the telephone serving as both transmitter and receiver. The apparatus is shown in fig. 1. The same firm has devised an

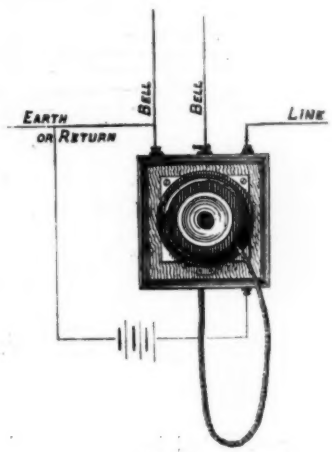


FIG. 2.

arrangement whereby telephones may be employed upon the ordinary wires provided in a house for an electric bell service. The telephone (fig. 2) is a small single-pole Ader receiver carried in a clutch-plate fitted to a base board, which is fixed to the wall. It serves as both transmitter and receiver, and is connected in place of the press buttons in the various rooms. Fig. 3 is a diagram of the connections. A telephone

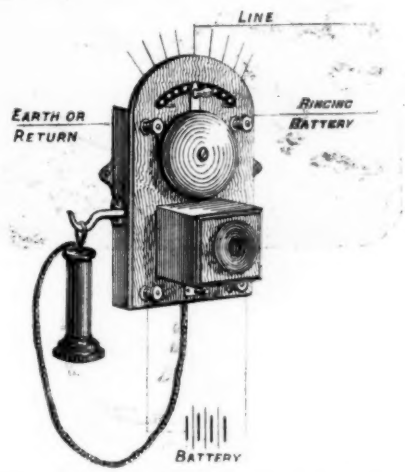


FIG. 4.

and small switchboard are provided in the kitchen, and the different lines, before being led to the indicators, are carried to the springs of the switchboard. The telephone in the kitchen is connected on one side to a common return wire, and on the other to a flexible cord carrying a plug. On removing a telephone in any room the indicator in the kitchen falls, and the bell rings. The servant inserts the plug into

the switch springs corresponding with the indicator; this cuts out the indicator coils, the bell and battery, and connects the telephone to line. By means of this simple device all the rooms in a house fitted with electric bells may be enabled to communicate with the kitchen at a trifling outlay for the telephones. The arrangement is simple, there is little to get out of order, and it will no doubt open up a field for usefulness.

The same firm are exhibitors and makers of a very efficient and compact form of automatic switch (fig. 4). It is capable of accommodating up to about a dozen circuits without the use of cords or plugs, and is intended for connecting together different offices or departments, and for avoiding the inconvenience which would be caused by the user neglecting to replace the switch in its normal position after using the apparatus.

A cable containing two more wires than the number of stations to be served is laid between the different points to be connected. The ringing battery is placed on the two extra wires. In every case the particular line belonging to

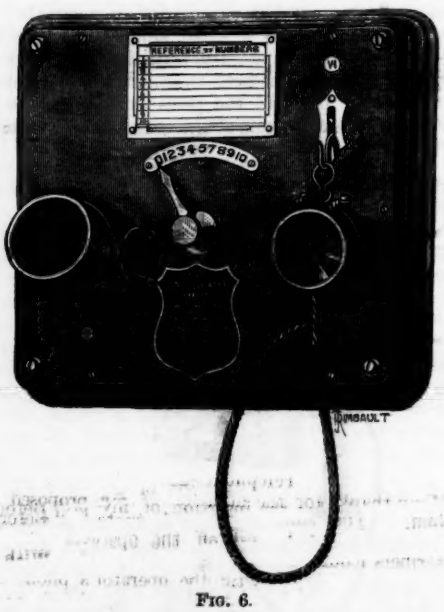


FIG. 6.

the instrument is connected to the centre stud, and those belonging to the other points are connected to the studs corresponding with their station numbers.

The switch is manipulated by moving the handle into contact with the stud belonging to the line required, and holding it there until the call has been given by depressing the calling key. The receiver is then lifted off the hook, the switch handle remains in the position where it was placed, and the telephone is in connection with the line indicated. When the telephone is replaced on the hook, the switch automatically returns to zero, and the normal connections are restored. The arrangement is very neat and compact; the whole apparatus comprising the switch lever and connecting studs, call bell and key, microphone and telephone, being mounted upon a polished teak board about 10 inches by 7 inches.

Fig. 5 is a diagram showing the connections for five stations. The identification of the wires at the different points is facilitated when the apparatus is being fitted up, by using wires having different coloured coverings.

The Consolidated Telephone Company was one of the first to introduce a switch of this class, and at their stall may be seen some very neat specimens of the apparatus. Fig. 6 is a representation of such a board, manufactured by them, providing accommodation for ten stations.

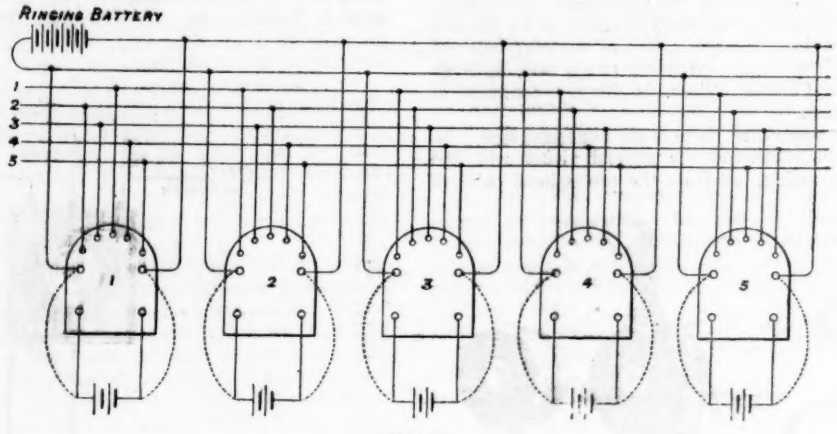


FIG. 5.

The International Electric Company are exhibitors of yet another variety of apparatus, intended to meet the same requirements, and termed a "line selector." It will be seen that a plug and cord are employed for making the necessary connection with the line selected, instead of the index finger provided in the boards previously described. Fig. 7 shows

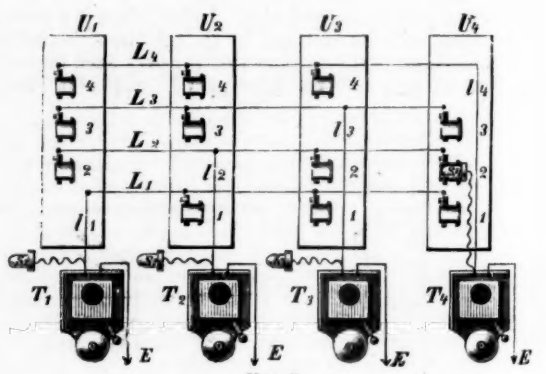


FIG. 7.

the connections for four stations. T_1, T_2, T_3, T_4, represent a complete telephone at each point, where also are placed "line selectors," U_1, U_2, U_3, U_4, having a number of switch holes corresponding with the stations in communication. Connection with any station is obtained by inserting the plug, S_1, S_2, S_3, or S_4, attached to each respective instrument into the switch spring of the line required. L_1, L_2, L_3, L_4, are the lines at any station whence it is desired to communicate with particular points only on the system, the number of holes in the line selector may be reduced to correspond with the number of stations required, thus:—Supposing A desires to communicate with one point only, B with four different stations, and C with all, A must be provided with a single hole line selector, B with one having four holes, and C with one having as many holes as there are stations on the system.